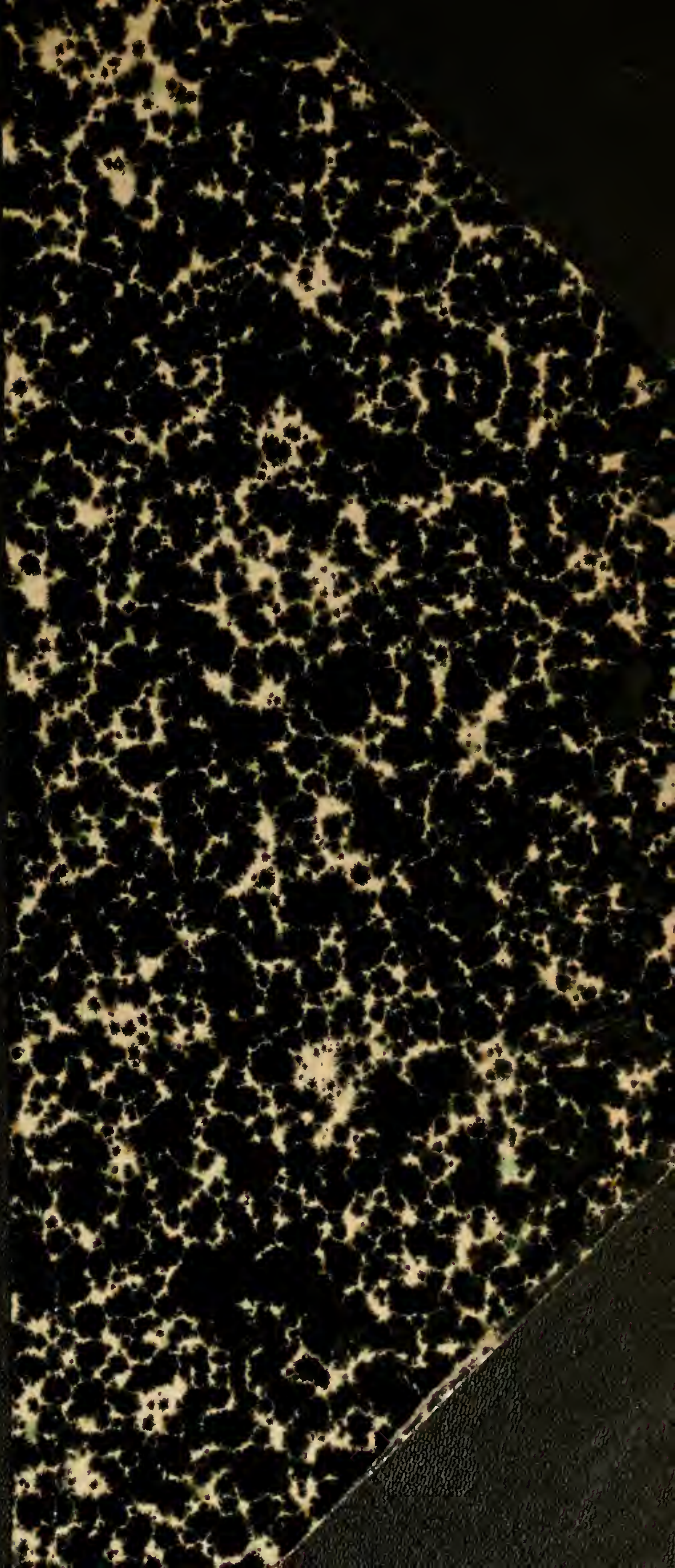

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of General Botany

Volume 13

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Volume 13 Number 1

THE PLANT WORLD

A MAGAZINE OF GENERAL BOTANY

JANUARY, 1910

HEREDITY IN POPULATIONS AND IN PURE LINES.

By L. R. WALDRON.

A contribution * on heredity in populations and in pure lines from W. Johannsen, Professor of Plant Physiology at Copenhagen, has recently commanded considerable attention, and it seems worth while to present a brief review, even at this late date, as the results are not generally accessible to American students. Johnansen worked mainly with beans (*Phaseolus vulgaris*) in pure lines. By a "pure line" is meant the offspring of a single seed, known by the experimenter to have been so derived. As bean plants are self-pollinated there was no trouble in keeping the lines pure.

Galton's researches upon the relations of offspring to parents evidently acted as the stimulus to this piece of work; as his studies of human stature and of sweet peas are particularly cited. In his researches Galton secured a number of sweet pea seeds and made weighings of them, and from these he selected seven sets for planting. Plantings of these seeds were made in various parts of England.

The tabulated results from these experiments are shown graphically in Fig. 1. * * The classes are the seed diameters

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*Ueber Erblichkeit in Populationen und in reinen Linien, Jena, 1903.

* *The relations between offspring and parents in regard to any character that may be measured or weighed can be nicely expressed upon coordinate paper. We may let the variable y represent some character of the parents while the variable x would represent the corresponding character of the offspring. In the case of Fig. 1, we are dealing with the diameters of sweet pea seed expressed in hundredths of inches. The mother seeds, which we may consider as parents in this discussion, were grouped into seven classes, the diameters ranging from 15 to 21 hundredths. The values of y_1, y_2, y_3,. . . . . . . y_7, are equivalent numerically to 15, 16, 17,.......21. The offspring of each of these classes were kept by themselves and the seed diameters ascertained. These are represented by the values x_1, x_2, x_3 ....x^7, and in this case are numerically equivalent to .153, .160, .156, .163, .160, .173, and

Galton found that the diameters bore an almost simple direct proportion to the weights. The figure illustrates very nicely the well known law of regression which may be expressed as follows: Adult offspring, taken as a whole, deviate in the same way as their parents from the mean of the race, but in a lesser degree. That is, if one were to pick an extreme parent from a population one could expect, according to the law, that the offspring would also be extreme, but to a lesser extent than the parent. Therefore, by continued selection, one might shift the type of the race on that line along which selection was being continued. Regression in the case figured amounted to one-third. In other words, a selection of three parental units is necessary to effect a one unit change in the offspring.

Apparently the original idea of Johannsen was to test out this law in pure lines as well as in populations. For this purpose he secured a quantity of beans of one variety which were apparently quite uniform. The average weight was 495 mg. per seed. A number of beans (286) were selected out, most of them nearly the mean in weight, but the extremes of the variety were also represented. The weights of the offsprings (seeds) of these classes were determined and the results showed a regression similar to that obtained by Galton with sweet peas (see Fig. 2). In this instance the regression was only about one-sixth.

The first filial generation from the original individual beans was grown in 1901, and to continue the experiment, a certain number of the pure lines were grown in 1902. The lines of 1902 were a continuation of those inaugurated in 1900. The data of the pure lines were used not only alone but also in connection with the study of the "population" *i. e.* the variety taken as a

---

.175 inches. Now it is apparent that a single point upon the squared paper may represent not only the value of y but of x also. The position of the upper cross in Fig. 1 indicates that the parent seeds of that class had a diameter of .15 inches while the filial seeds had a diameter of 153 inches. When one plots the parental and filial classes of any character, as found in a random sample of the race, then one presumably obtains a picture that expresses the relation of the offspring to the parents as far as the character in question is concerned. Galton "smoothed" his filial results, evidently by applying the best fitting straight line to the crosses seen in Fig. 1. The crosses of a "smoothed" table would therefore, lie along the dotted line of Fig. 1. Johannsen's observed results evidently approximate more closely to the theoretical straight line joining the means than Galton's. If the offspring had followed the lead of the parents exactly and had there been no regression, the crosses would have coincided with the line of 45 degrees.

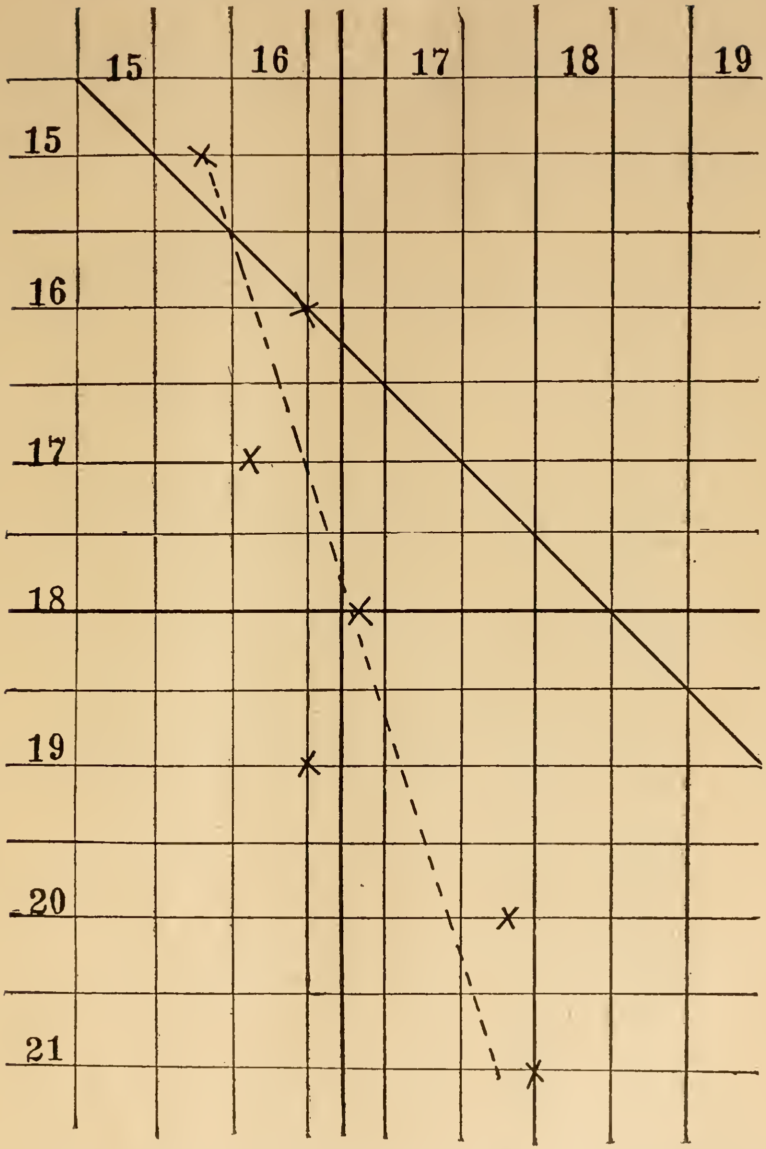

Fig. 1. Relation of offspring to parent sweet pea seeds as studied by Galton in a population. In this figure, as in the others, the parent values are arranged along the ordinate and the offspring values are arranged along the abscissa. The numbers in the figure apply to the ordinates or to the abscissae immediately below or to the right of the numbers and represent hundredths of inches.

mass. In 1902, 19 pure lines were planted for weight studies. Inside of each pure line, selections were made of some of the medium weight bean seeds, but particularly of the seeds near the extremes. The following table gives the data of one line. All weights are in milligrams.

Weight of grandmother bean (1900): 270
Mean weight of the mother seeds (1901): 510

Weight Classes of the mother seeds (1901).	Characters of the Offspring (1902).		
	Mean Weight.	No. of Seeds.	Standard Deviation.
200–250	469	18	59.4
450–500	446	131	68.1
600–650	450	39	63.7
The entire line	449.5	188	66.3

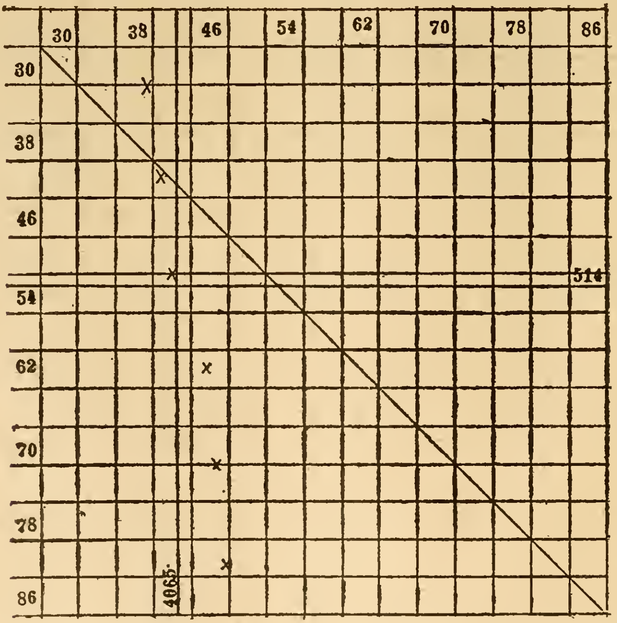

Fig. 2. Relation of offspring to parent bean seeds in regard to weight, as studied by Johannsen in a population. The numbers at the ordinates and abscissae in this and the following figures represent centigrams while the numbers on the mean lines represent milligrams.

Each of the 19 pure lines was treated in this manner and in several cases more weight classes were used for each line. If we take the mean weights of the mother classes and the mean weights of the daughter classes, a regression table may be formed similar to the one in Fig. 2. Such a table is shown in Fig. 3.

The results in this case are markedly different from those secured when the material was studied as a population. Here we do not have a fine example of regression as is shown in Figs. 1 and 2. It must not be forgotten that both Figs. 2 and 3 represent the facts, but in Fig. 3 the data are so presented that we see the sequence of the two related means *i. e.* (means of mother and daughter classes) in the various cases. There is evidently a certain amount of regression expressed in the table, but apparently little can be learned from it in regard to the value of selection.

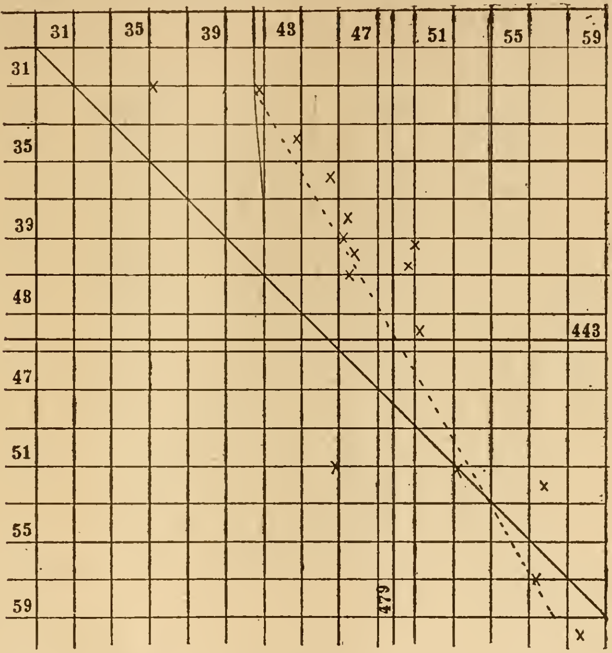

Fig. 3. Relation of offspring to parent bean seeds in regard to weight as studied by Johannsen in pure lines. Compare with Fig. 2. The dotted line is the line of regression.

STUDIES OF RELATIVE WIDTH.

Studies were also made upon the relative width of bean seeds. The width, in millimeters, was divided by the length similarly taken and the quotient expressed by three figures as a whole number. Studies were made, as before, of the beans as a population. Studies were also made of the beans in pure lines. Fig. 4 shows the regression found in the population.

This figure shows a regression of about one-fourth and is much the same as that seen in Fig. 2. If we take the means of the parent lines and the means of the corresponding offspring, in the study of the pure lines, a regression table may be constructed similar to that shown in Fig. 3.

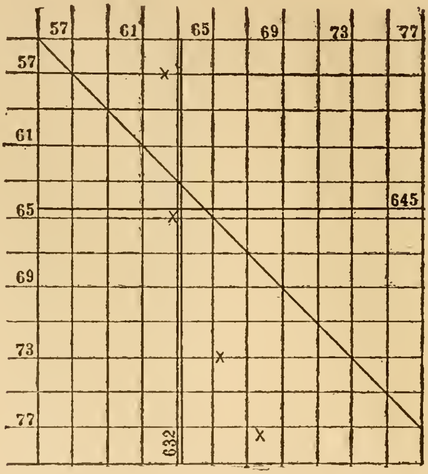

Fig. 4. Relation of offspring to parent bean seeds in regard to relative width, as studied by Johannsen in a population.

In this instance, Fig. 5, we obtain a very interesting result. Instead of there being any regression as seen in Fig. 4, the correlation is nearly perfect and the line of regression nearly parallels the line of 45 degrees. Taken as a population, the bean weights seem to corroborate Galton's law of regression. When practically the same material is used, but treated by the method of pure lines. then the regression disappears entirely and the offspring take the lead of the parents.

Now it is evident that the selection of individuals from a population, on the basis of a certain character, will bring about a very rapid result. But the result is not coincident with any change in the race indicating a shifting of type. It consists merely in the complete or partial isolation of a form. If small seeds are chosen from a mixed lot, we will be apt to secure small-seeded offspring, as a whole. But in our choice of small seed, we are also apt to include some minus variants of large-seeded lines. On the other hand, the selection of large seeds from a mixed lot will most likely result in the securing of large-seeded offspring, but in this case we will be apt to include some plus variants of the small-seeded lines. A consideration of these facts will lead us to understand how it is that the relations of offspring to parents are such as shown in Figs. 1, 2, and 4, when no regard is paid to the transmissive power of the parent seeds; in short when no attention is paid to pure lines. We can say in any case that "a race with six generations of selection will breed true within 1.2% truth ever afterwards." As a matter of fact, a pure race may be secured in a less period of time, even in one generation. In short, the increase of one plant brings about a pure type. If, however, selection is made to one line or biotype, which continually crosses with another line, then the purity of the line through selection may be indefinitely postponed.

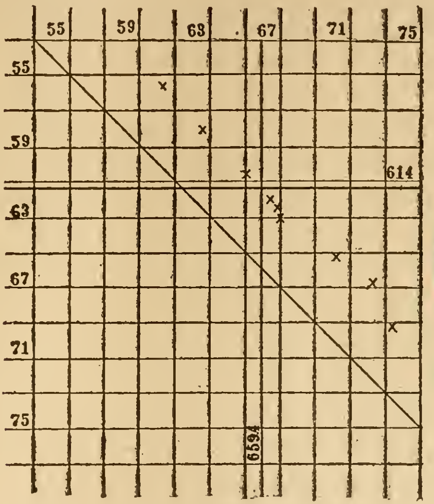

Fig. 5. Relation of offspring to parent bean seeds in regard to relative width as studied by Johannsen in pure lines. Compare with Fig. 4.

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In general, American breeders are committed to the principle of the isolation of individual plants. Continental breeders, with some notable exceptions, were evidently much slower in utilizing this idea and it is doubtful if even now the value of the method is fully appreciated. Thus it is likely that Johannsen's paper is best appreciated by European breeders who have held to the idea that selection within a variety has brought about a rapid change or type-shifting, such change being really only an isolation of types or lines that breed comparatively true. Joannsen made this idea emphatic, but at the time of the appearance of his paper American breeders had largely developed away from the idea that selection *en masse* brings about any shifting of the type.

While American breeders in endeavoring to obtain a pure type of a self-pollinated form, do not select *en masse*, yet many experiments that are being conducted are almost certainly being vitiated in part by the failure to recognize the existence of pure lines in breeding true within one variety. These lines manifestly have different yielding capacities, under the same or different conditions. The whole question of acclimatization needs to be reviewed, as far as the types of plants under consideration are concerned. The experiments that have been made in the changing of seed grain from one region to another may need to be re-investigated. The continued selection of large and small seed grain from an original population would doubtless be nothing else than the more or less complete isolation of the various types. In such experiments the material needs to be subjected to a more critical biological analysis than has hitherto been accorded. As Johannsen indicated, the principle of pure lines may help in explaining "degeneration" which often appears to take place in certain crops.

As indicated, Johannsen endeavored to change the mean within the pure lines by selecting extremes of seeds as parents. A slight change was made in the relative breadth of seeds but the change may have been accidental. Johannsen's conclusion is, "the personal quality of the parents, grand parents or some other ancestor has no influence, so far as my studies go, upon the average character of the individual." Galton evidently considered his maternal sweet pea seed as the "parents" and was apparently of the opinion that a selection of extreme size of mother seeds would bring about a change in the offspring consonant with the selection. Johannsen in following the same plan has perhaps fallen into an error and this has been noticed by Weldon and Pearson. * If individual plants had been chosen for parents and had the characters been taken from the means of the seed of such entire plants selected, then a more logical starting point would have been secured. This would have entailed the growing of another generation. Our author certainlv did not show that the extremes of seed in one plant have no appreciable effect upon the similar qualities of the offspring seed. It seems that he laid too much emphasis upon his showing that the selection of fluctuations had no hereditary value when these fluctuations were empodied in one plant.

Johannsen recognized very well that chance must largely govern the size of seeds upon one plant. The end bean in a pod is, of course, smaller than the middle bean. But in spite of this knowledge, he uses the different sizes of seed from one plant as a basis of selection. We may easily conceive that the seeds of one plant may vary germinally as well as somatically. Then if seeds having germinal variations were selected, such variations would appear in the offspring. The somatic or partial variations are considered by everyone to be only transient. To get up an argument over them is too much like setting up a man of straw. As Johannsen has treated the problem, the partial variations mask the germinal ones. No basis is afforded for the measurement of the various parents within the pure lines. Strictly speaking, there are no different parents for the various sub-lines. To secure such parents another generation would have been necessary. It seems, then, that Johannsen has not demonstrated the futility of selection within the line. He did not show that the seeds of one plant obey Quetelet's law, which of course was well known.

Plate** criticizes Johannsen's work by stating that the self-pollinated pean plants have become less variable than organisms that interbreed. Johannsen denies this idea of Plate's. At this point we must discriminate carefully to avoid confusion. According to our author's hypothesis, the pure line is a fixed type and thus far Plate's criticism is correct, though such fixed types may have been in existence for a long period. But there is nothing to show that a *variety* of beans, such as the Princess beans, from which Johannsen secured his pure lines, is less variable than a variety of corn which constantly interbreeds. The standard deviations and the coefficients of variability may be as great in the variety of corn as in the bean variety.

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*Biom. II, 499.

**Archiv. f. Rassen-u. Gesel-Biol., I, 136.

In a later article * Johannsen seeks to show that when different varieties of beans are crossed, the variability of the hybrids is no greater than that of either parent. His results are certainly interesting but are scarcely conclusive. He deals here with the seeds of plants, using the seeds as a measure of the variability. Again he brings into consideration the partial variations induced by the accidental environmental conditions of the year. These would have arisen under any condition and their presence in the data may be insufficient to mask the germinal variations, which are evidently those in which Johannsen is interested. The data of the next generation should have been taken and the means for the characters established for different plants individually.

Johannsen's work has been of inestimable value in bringing out clearly the existence of pure lines of biotypes. He has shown that they are of enough importance to be reckoned with in heredity studies. He has shown in a statistical manner that the variety can no longer be considered as a unit and that statistics dealing with populations, while they may present facts, have little application for the students of heredity. The facts do not speak in terms of evolution. He has shown that a variety, a race, a population, does not have a biological mean and that selection can not be made upon the basis of the law of ancestral heredity. His paper is almost epoch making in its relation to the theory of unit characters in self-pollinated forms. The idea, to be sure, has been dominant at Svaloef since 1892, and was championed in a way by DeVries, but Johannsen gave the idea a statistical foundation which can not be easily set aside. Johannsen has not disproved the idea that selection shifts the mean. It is evident that he could not have done this had his methods been correct. The onus of the argument is with those who hold the idea valid.

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*Rpt. 3rd Int. Conf. on Genet, London.

Johannsen's results seem to pave the way for a partial solution of the long vexing problem of the value of continued selection as against the view that changes arise in a saltatory manner. The application of the biotypic hypothesis leaves little ground for dispute between the two schools. Selection must be considered as a purely subjective process and its result is merely the isolation of a form or type, differentiated to a greater or less degree. If germinal variations are not present in the organism, then selection avails nothing. Johannsen has shown that fortuitous germinal variations of very small magnitude may exist. Such variations are so small that they would easily escape notice without a critical analysis. They are neither necessarily meristic nor morphological in character. It is evident that variations of this nature, mean weight of seed, etc., have been confused heretofore with mere fluctuating variations. The value of selection from a "population" may be considered as a purification of the race and not a shifting of the type. Johannsen applied the term "biotypes" to the various pure lines that breed true and which are sensibly different from one another. The term is a good one but it should be used in a plastic sense, at least until we know more of what constitutes a "biotype."

Inasmuch as we find biotypes in cultivated varieties, their origin must be comparatively recent. If, as seems likely, their presence affords the basis for improvement in selection, then it is probable that they are arising more or less constantly. In course of time it may be shown that their appearance is dependent upon definitely controlled cultural conditions. But we must assume that they also arise in a truly fortuitous manner. From these considerations it appears that continued selection along some definite line may bring about certain results. But this would only happen if the variations were taking place along the line of selection. An analysis of the material comprising the variety and a study of some of the pure lines for one or two seasons might enable the breeder to judge of the possible value of selection in the variety in question. If, within any variety, germinal variation is manifested in only slight degrees then it may become a matter of difficulty to determine if any progress by selection is being made. Mere observation of the plants will hardly avail us. They must be studied by the best statistical methods and even then many systematic errors will be encountered. It is scarcely necessary to state that the field indicated is practically a virgin one, as almost no exact scientific work has been carried out. Johannsen has but indicated the way.

Interesting points are involved as to the relation of biotypic to Mendelian characters. Two biotypes distinguished from each other merely by a moderate difference in mean seed weight or by a character equally slight, may Mendelize upon crossing but the discernment of such a phenomenon would scarcely be possible. But there must come a time in the history of the variety or of the race, when differentiation is great enough so that segregation may be noticed. Does this difference arise at once, or by a summation of biotypic variations?

Laboratory Experimental Plant Breeding,
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AN INTERESTING MARASMIUS FAIRY RING.

BY HOWARD S. REED.

The accompanying illustration shows a distinct "fairy ring" formed by *Marasmius caryophylleus* (Schaeff.) Schroet. (*M. Oreades*), observed by the writer in September. This fairy ring was found in a small grove of hemlock (*Tsuga Canadensis*) on the campus of the Virginia Polytechnic Institute. As shown in the illustration, the ring was approximately centered around one of the hemlock trees located in the densest part of the grove. On the left of the tree, where the ground was several inches lower, the ring was interrupted by several wide distances in which no fungi appeared. Nevertheless the ring could be quite distinctly traced around the tree.

This very definite arrangement of the fairy ring with reference to the tree suggests some interesting questions regarding the probability of mutual action between the two. The surface of the soil was everywhere covered with fallen needles from the hemlock, and therefore equally subject to the action of the terpenes which they might contain or other organic compounds, arising from the decomposition of the needles. The soil is, however, subject to the action of compounds brought down by the rain-water, which trickles off the trunk of the tree and comes to the soil close to the foot of the tree. It is well known that hemlock bark contains large amounts of tannin, for which it is valuable as an article of commerce. It seems quite certain that the rain-water trickling off would bring to the soil greater or less quantities of this substance, which is known to act deleteriously upon vegetation. Livingston * has shown that the rain-water gathered from oak and chestnut trees had a deleterious influence upon wheat seedlings and the author * * has previously published an instance of the deleterious action of a Kentucky coffee tree upon ornamental plants growing about its base.

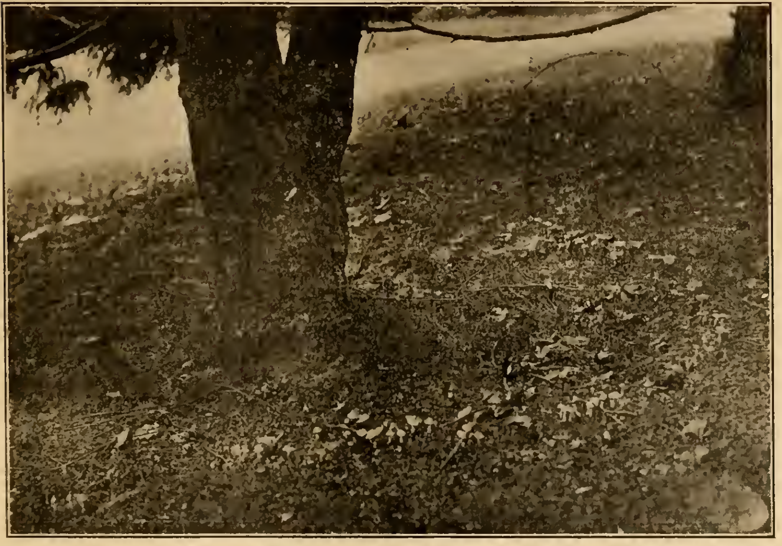

Fig. 6. Fairy ring centered around a hemlock tree

In the present instance it is evident that the poorest growth of the fungi is on the lower side of the area, where any excess of water which does not percolate into the soil would flow over its

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*Bull. 36, Bureau of Soils, U. S. Dept. of Agr., 1907.

* *Plant World, 12:279, 1907.

surface, and during long, heavy rains this has been noted actually to occur.

The possibility of a mycorrizal association was not investigated, although in view of the recent work of Pennington and others such * an association might exist; but it is not quite plain why the fungi should grow in a definite ring if this were the only biological factor determining the relationship.

Virginia Polytechnic Institute.

A NEW FLORA OF CALIFORNIA

By S. B. Parish.

Thirty years has elapsed since the completion of the botanical volumes of the Geological Survey of California. The great botanists of that earlier time have passed away; new men, with new views, have succeeded them. The science itself has greatly advanced, and taxonomy has not been left behind. Our territory, then but half explored, has now few recesses unvisited by the keen-eyed collector, whose labors have enriched our public and private herbaria. Our flora has been diligently studied in the field and in the closet, and these investigations have resulted in an extensive literature which is scattered in botanical journals and the proceedings of learned societies, in monographs and occasional papers, and in local and general floras. Of all this he who would study the flora of California must take account, for up to the present day the Botany of the Survey remains the only work covering the plants of the entire state. But adequate as was that great pioneer work, and useful as it still remains, not only has it long been out of print, and with difficulty procurable, but it has been left behind by the advance of time, a destiny from which all works of its kind can be saved only by frequent revisions. It is true that manuals have been provided for in the vicinity of our two largest cities, but these, while reliable in their proper territory, contain pitfalls for the inexperienced when used beyond those bounds.

The time is, therefore fully ripe for a new flora which shall gather up all this scattered knowledge, and arrange it in accordance with the present state of botanical science, that it may be readily available to the student. Such a work is now undertaken and we have before us the first two parts in which it is to be issued. These do not begin the work, nor are the two continuous. The first treats the Pinaceae, Cupressaceae and Taxaceae; the second covers the families from Salicaceae to Urticaceae.

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* Michigan Academy of Science, 10:47, 1908.

†A Flora of California, by Willis Linn Jepson, Ph. D., Assistant Professor of Dendrology in the University of California. Illustrated with many original figures. Cunningham, Curtis & Welch, San Francisco. 1909.

We notice first the generous page, the satisfactory paper and typography, and the excellence of the numerous illustrations. And here we find something new in a book of this kind, for besides the usual figures there are a number of full page halftones showing the appearance, the habit and the haunts of the trees. This seems to us an admirable innovation, carrying the book from the study into the field and the forest. Noticeable among these is the fine plate showing the crown of the sugar pine, and the two plates illustrating the Redwood, the first bringing out the close stand of the forest, and the second the method of logging. *Cedrus rhombifolia* is illustrated with a habitat plate that is artistic as well as scientific, and *Quercus obata* with a plate showing its characteristic drooping branchlets. The ecological plate of the "Bald Hills" is less successful, the sun-whitened grass giving the effect of a snow-clad winter landscape.

The descriptions are ample, but not unduly prolix, and the keys will be found to lead the student readily to the identification of his plant. Great care has evidently been given to the notes on the distribution of the species, which are full and unusually accurate, the author having the great advantage of a wide and close field knowledge of the California flora. In the notes on the Big Tree the location of all the groves is given, and the area of each and the number of its trees. Much information is also included regarding habit, economic uses, and other points of interest.

When the entire book shall have been completed, on the scale indicated by these parts, California will possess a state flora far superior to any similar work. A state flora has long been impatiently desired, and more than once projected, but we may well be content to have waited so long, now that it is to be so worthily provided.

AN ANIMAL FACTOR IN PLANT DISTRIBUTION.

By J. C. BLUMER.

The Rincon mountains of Arizona possess an ecologic factor of no small importance in the form of a small rodent (*Thomomys* sp.). It inhabits in large numbers the Canadian pine region, especially on the west side of the mountains, and extends down into the Transition zone. Its work was also found to a lesser extent in the high pine region of the Chiricahua mountains.

The animal appears to be somewhat variable in color and form, and may represent a variable species or else more than one sub-species. This timid, circumspect, and industrious little brown mammal does a large amount of work in the autumn between the close of the rainy season and the advent of cold weather. Over large areas, both on ridges and slopes and in canyon bottoms, its mounds of earth are conspicuous. Frequently, especially on top of ridges, the soil is so honey-combed with its runways that in walking over it, one sinks through as though walking on thinly crusted snow. In the sunny days of October, especially before a change of weather,it is very busy with its burrowing, making many surface openings, always from below, along its tortuous and much-branched underground runways. A part of these, oblique in direction, it uses to expel the excavated dirt, therewith building its conspicuous chains and groups of mounds. Other shafts, usually more vertical, are opened for foraging purposes, gathering for its winter nest dry leaves and stems, grass, and other loose material that may be within a radius of about twice the length of its body. If grassy tussocks are at hand the rodent digs into these, utilizing the grass roots for food or nesting purposes. It probably lives largely on the roots of various perennials encountered along the route of its diggings and is responsible for the killing or crippling large numbers of these by cutting the roots or burying the plants. On the other hand, it is probably instrumental in favoring the germination of many seeds and the establishment of many young plants that otherwise would not come into existence. This is brought about by the throwing up of the loose soil in which become imbedded during the autumn, chiefly by the aid of wind and gravity, large numbers of seeds. The mounds weather down and spread out under the influence of wind, rain, frost and melting snow, produce a favorable seedbed, and the following summer give rise to colonies of young plants, among which annuals are especially numerous. This animal may thus be responsible to a considerable extent for the unusually large proportion of annuals in the flora of many parts of the high Rincons, and may disturb the balance of competition in this as well as other directions.

It may be easily inferred that the animal exerts a large influence upon the plant life also indirectly. The many tunnels give access to the air with its daily and seasonal fluctuation in temperature, and probably admit more or less water from the rains and snows, introducing frost action. This aids disintegration of the underlying rock, while the generally loosened soil is more easliy transported. Extensive burrowings are not infrequently found in gravelly soil so shallow that the runways are in contact with bedrock, yet barely hidden beneath the surface. The nesting material decays and increases moisture capacity and fertility, and for this and other reasons subsequent abandonment of an area results in marked benefit to the plants. The animal thus amounts to a geological as well as an indirect botanical factor, and modifies soil temperature, soil moisture, its depth, consistency, aeration, and undoubtedly its bacterial life as well. Its direct harmful effect in the destruction of roots may possibly be offset in a measure by the destruction of larvae and other animal life harmful to plants.

The relation of the little mammal to forestry is interesting. In its domain the forest is composed mainly of *Pinus arizonica* and *P. strobiformis*. The reproduction is remarkably good, particularly on the more open slopes and ridges where usually the rodent work also is or has been prominent. Many young seedling trees are growing in a cover of pine needles under mature trees, places where ordinarily such are rarely seen. Upon close inspection mineral soil may be found under the needles, the remains of mounds of the rodent. Frequently young pines may be seen in juxtaposition with the mounds, whereas they are rare in adjoining places without the exposed mineral soil which is practically indispensable to the establishment of successful young seedling trees in a forest. One instance is particularly noteworthy. A veteran pine was found standing in the open, the ground beneath littered with cones, and many hanging on the branches. Directly beneath the periphery of the rather broadly spreading crown a well marked band of young pines encircled the tree. The largest number of seedlings had evidently arisen where the seeds had fallen the thickest, with other conditions favorable. At one point in the circle the young trees were much larger and thriftier and stood more densely. Among them could be seen, in a state of decomposition, several mounds of earth, the end of a line of entrenchments made by the little rodent, while no other mounds appeared within the area covered by the band of trees. It is quite probable that the fine young generations of pines owe their existence in no small measure to this successful little mammal.

Tucson, Arizona.

NOTE ON PEKLO'S WORK WITH MYCORHIZA.

BY BENJ. C. GRUENBERG.

In a preliminary publication on some studies made with the mycorhizas of *Carpinus*, *Fagus*, *Alnus* and *Myrica*,* Prof. Peklo announces the isolation of the organisms that give rise to the root tubercles in these plants, although he sees no reason to suppose that other species of fungi may not have similar effects in other localities.

Having found the usual hanging-drop method of culture unsuited for the isolation of the fungus in mycorhiza, he resorted to a decoction of the mycorhiza itself as probably containing the materials available for the growth of the fungus. In this way he succeeded in observing the outgrowths of hyphae from the mycelia of mycorhiza sections of *Carpinus* and of *Fagus*. The action of the decoction is specific to a considerable degree, that is, foreign fungi do not readily thrive in it. Conidia were produced in about three days. From *Carpinus* there was frequently separated a form of *Penicillium* (*Citromyces*) resembling the species described by Oudemans as *geophilus*. From *Fagus* several species of *Penicillium* were obtained, a form of *Citromyces* occurring most frequently. Pure cultures of these fungi grew well in Raulin's fluid (in which tannin replaces sugar as the source of carbon); and this is taken to confirm Peklo's theory that the fungus in these mycorhizas is one adapted to utilizing the tannins produced in the roots in response to the irritation of the fungus. Inoculations of seedlings with the pure cultures resulted in well-developed mycorhizas on beech roots, from *Citromyces* as well as from *Penicillium.*

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*Beitrage zur Loesung des Mykorrhizaproblems Ber. der deutschen bot. Ges. 27:239-247. June, 1909.

From the alder swellings he separated a species of *Streptothrix,* and from *Myrica* a form of *Actinomyces.* Both organisms grew well on a mixture of malt worts with potassium carbonate and di-potassium phosphate. The *Actinomyces* showed certain physiological similarities to pathogenic forms, and also to the bacillus of tuberculosis. Two seedlings of alder were infected with the pure culture of the isolated organism; the root-hairs were entered by the fungus, without being injured, though they showed the swelling and branching as described by Hiltner; but no tubercles were formed on any of the rootlets.

The dependence of the fungus upon the roots is inferred from the fact that the cultures (of *Penicillium*) thrive in solutions in which tannin is the sole source of carbon, together with the conclusions of Reinitzer and Nikitinsky to the effect that these fungi can not get their carbon from the humus, from which they get only their nitrogenous material. Tannin is produced in the roots attacked by the fungi; this (and perhaps also the character of the cell walls) confines the fungus to the intercellular spaces. Peklo offers no hypothesis as to the compensation which the "host" receives from the fungus.

THE CHEMICAL ORGANIZATION OF A TYPICAL FRUIT.

BY A. E. VINSON.

The cane sugar in a green date of the invert sugar type remains as cane sugar for many weeks in spite of the presence of large amounts of invertase. When, however, the physical integrity of the fruit is disturbed, as by grinding or crushing, inversion of this sugar takes place with great rapidity. Previously published work shows no appreciable difference in the distribution of this invertase in the date as regards apical, middle or basal end, or outer, inner or tannin zones. The rapid inversion of the sugar must then be induced by the increased mobility of the sugar, due to mechanical disintegration of the tissues, and to free exposure of their intracellular invertase. Mechanical injury does not release or render mobile this intracellular invertase in the sense that it releases sugar and soluble nitrogenous compounds, although treatment of the fruit over night with acetic acid vapor renders its invertase readily soluble in glycerol.

A quantity of green fruit was ground and crushed rapidly with a meat cutter. The juice running from the mill was filtered at once, to remove the pulp. The pulp was then pressed as rapidly as possible in a Buchner press and the juice obtained at various pressures kept separately.

1st Experiment; fruit immature:

Pressure in atmospheres.	Direct polarization sugar scale.	Inverted 26 degrees C.	Per cent cane sugar.	Nitrogen in 25 c.c. of juice.
0	+8.7	−4.8	10.4	.0234 gms.
0 to 50	−2.5	−4.8	1.8	.0266 "
50 to 100	−3.3	−4.9	.1.2	.0334 "
100 to 350	−3.4	−4.9	1.1	.0321 "

The inverting power of these portions as determined by mixing 75 c. c. juice, 75 c. c. water and 20 grams cane sugar, was as follows:

Portion.	Initial polarization sugar scale.	End of 3 days.	End of 7 days.
0	+15.0	+15.0	+14.5
0 to 50A	+10.1	+ 9.5	+ 6.8
50 to 350A	+ 9.6	+ 9.7	+ 9.6

The portion obtained under low pressure, when fresh, can not be filtered clear through paper, but after standing shows considerable sediment. The inversion was with the turbid juice and undoubtedly due to the small amount of insoluble matter present.

2nd Experiment; same date, more mature.

Pressure in atmospheres.	Direct polarization sugar scale.	Inverted 26 degrees C.	Per cent cane sugar.	Nitrogen in 25 c.c. of juice.
0	+15.0	−7.3	17.2	.0262 gms.
0 to 50	− 2.8	−7.5	3.6	.0392 "
50 to 350	− 5.0	−7.4	1.9	.0307 "

Inverting power determined as before.

Portion.	Initial polarization sugar scale.	End of 4 days.	End of 7 days.
0	+17.6	+17.6	+17.6
0 to 50A	+ 9.7	+ 8.1	+ 6.0
50 to 350A	+ 8.8	+ 8.4	+ 8.5

These results show rapid inversion of the cane sugar after the fruit has been crushed during the short time taken to press the pulp. The total quantity of sugar in the juice which flows off by gravity and in the portion obtained under the highest pressure is practically identical. The soluble nitrogenous matter, however, increases greatly under increased pressure but is not accompanied by invertase, excepting in the portion obtained under low pressure, and in this case by only a small amount which appears to be in suspension only. Thus it is evident that in the uninjured green fruit the cell contents are so ordered that contact between invertase and cane sugar takes place but very slowly; that this intracellular invertase is not in solution and retained by the impermeability of the plasmic cell wall, but is held in an insoluble form probably in the protoplasm. Undoubtedly other enzymes involved in the ripening processes are similarly held, in which case absolutely no reaction could take place between them and other insoluble cell constituents. Upon the death of the protoplasm by poisoning with various chemicals or by the heat the green date ripens prematurely which, judging from the invertase relations is due to the solution of these hitherto insoluble enzymes. If the green date tissue is killed by grinding, washing with water and drying these same means no longer suffice to liberate the invertase; it remains permanently insoluble but active.

Arizona Agricultural
Experiment Station.

NOTES AND COMMENT.

One who, even casually, turns over the current literature of the day must be impressed with the fact that the feeding of the coming millions of the American continent is a serious problem, and that a large number of trained men and women, now boys and girls in the schools of the country, will need to bend their best energies to its solution. James J. Hill, in the *World's Work*, shows, conclusively as it seems, that in 1950 the 200,000,000 people in the United States will not have near bread enough to eat unless the present low wheat average can be substantially raised by better agricultural methods. To meet this pressing need he would build a couple of warships a year less, would take the money thus saved, and would start at least one thousand agricultural schools in the United States in the shape of model farms, which would furnish in every agricultural county where they are located a working model for common instruction in thorough tillage, the selection of seed, proper fertilization, alternation of crops, and the whole scientific and improved system of cultivation, seeding, harvesting and marketing.

The measures advocated by Mr. Hill have everything to commend them, and it is to be hoped that the agricultural colleges of the country will make haste to prepare for this service the thousand and more men so imperatively needed. Meantime it is to be noted that in the working out of such problems the longest way around may prove to be the shortest way home. Not many years ago, in a university town, the study of green algae was publicly singled out as one of the most unlikely things that a young man could take up with advantage either to himself or the community. Yet it is now a matter of common knowledge that the study of these and other insignificant organisms of our inland waters is preparing the way for obtaining harvests of food from these "water pastures" which may go very far to meet the predicted deficiencies in harvests from the land. Prof. W. A. Herdman, in an address before the British Association in 1909, discussed the distribution of plankton in time and space and gave some striking examples of its relation to food supply. The story runs thus: Man feeds upon the cod, which in its turn may feed upon the whiting, and that on the sprat, and the sprat upon copepods, while the copepods feed upon peridinians and diatoms. All such chains of food matters from the sea seem to bring one through the copepods to the diatoms, which may be regarded as the ultimate producers of food in the ocean. So our living food from the waters of the globe may be said to be the diatoms and other microscopic organisms as much as the fishes. Naturally, if supplies of food from these "water pastures" are to be utilized and increased in any intelligent way, there is nothing for it but to carry out investigations of the plankton in our fresh waters on a scale and with a thoroughness that has never yet been attempted.

BOOK EXCHANGE.

The following list of books on fungi, myxomycetes and lichens, bound and in good condition, is offered for sale. The prices named include postage.

DeBary.	Morphologie und Physiologie der Pilze, Flechten und Myxomyceten. Leipzig, 1866	$1.25
———	Vergleichende Morphologie und Biologie der Pilze, Mycetozoen und Bacterien. Leipzig, 1884	2.50
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Zopf.	Die Pilze. Breslau, 1890	3.00
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Massee.	Monograph of the Myxogastres. London, 1892	4.50
Lister.	Monograph of the Mycetozoa. London, 1894	3.50
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Sorauer.	Handbuch der Pflanzenkrankheiten. Berlin, 1874	2.00
Plowright.	Monograph of the British Uredineae and Ustilagineae. London, 1889	2.50

Cooke. Fungi: Their Nature and Uses. (The international scientific series). New York, 1875............	1.00
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FEBRUARY, 1910

TERATOLOGY IN JUGLANS CALIFORNICA WATS.

BY ERNEST B. BABCOCK.

It is the purpose of this paper (1) to record the occurrence of abnormal flowers, fruits and leaves in *Juglans californica* Wats., (2) to point out their probable significance in explaining the origin of certain anomalous forms of Juglans.

The normal blooming period of most wild trees of black walnut in southern California is in April. The staminate catkins appear first, being produced on the growth of the previous season. They are three to five inches long when fully grown and each catkin bears a large number of flowers. The pistillate catkins appear about the first of April, being terminal upon the new growth. They are one or two inches long and bear one to five flowers so that when the nuts mature they often hang in clusters (Fig. 1,a). Normal pistillate flowers are bisymmetrical.

Many trees throw out lateral branchlets from the first growth of the season. It is during this second period of growth, in May or early June, that the teratological flowers and leaves appear on certain trees. The abnormal flowers are usually produced upon catkins that resemble normal *staminate* catkins in number and arrangement of the flowers, although only two to three and one-half inches long. But the flowers are either *pistillate or bisexual*, or both, no purely staminate flowers having been found except in occasional catkins, which were entirely staminate. These abnormal late catkins usually occur on the second growth, lateral branchlets, one catkin in the axil of a leaf, but they sometimes develop alongside the normal, terminal, pistillate catkin as shown in figure 2. In Brea Canyon (Puente Hills) a hundred or more wild trees were examined during the season of

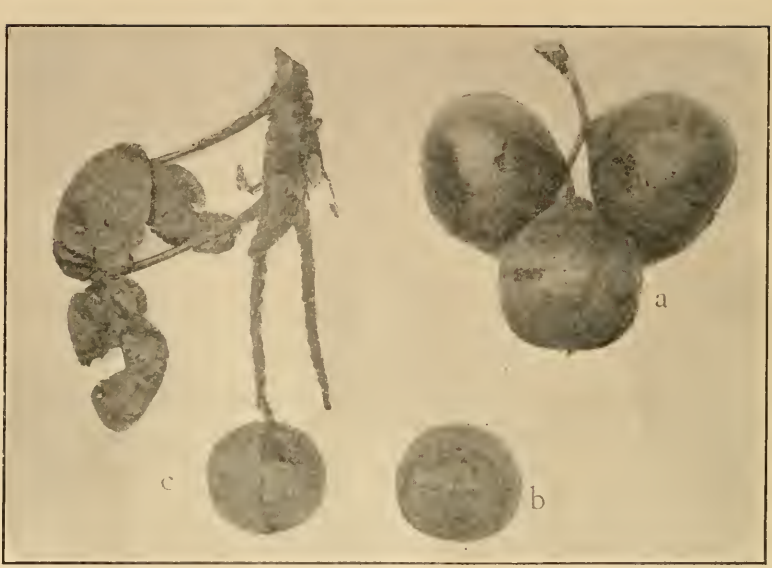

FIG. 1. Cluster of normal nuts of Juglans californica; b, c, abnormal nuts of same; b was attached as c was. More frequently nuts are developed at the base of the catkin.

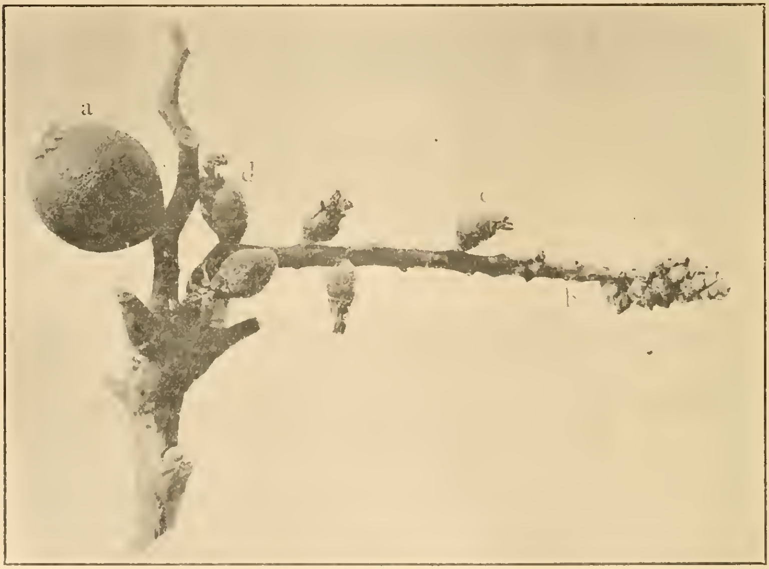

FIG. 2. Normal pistillate catkin with a developing nut; b, abnormal catkin with pistillate flowers; c, shows a symmetrical form; and d, the depression in surface of ovary.

1909, and while abnormal flowers and fruits were not of general occurrence they were very frequent.

The most striking characteristic of the pistillate and bisexual flowers is their form. They are asymmetrical, being flattened more or less on the side adjacent to the axis of the catkin. This is well shown in figure 2, c. Along with this flattening there is often a depression in the surface of the ovary, usually extending from the styles to the base of the ovary, or only part way, and of varying width. (Fig. 2, d).

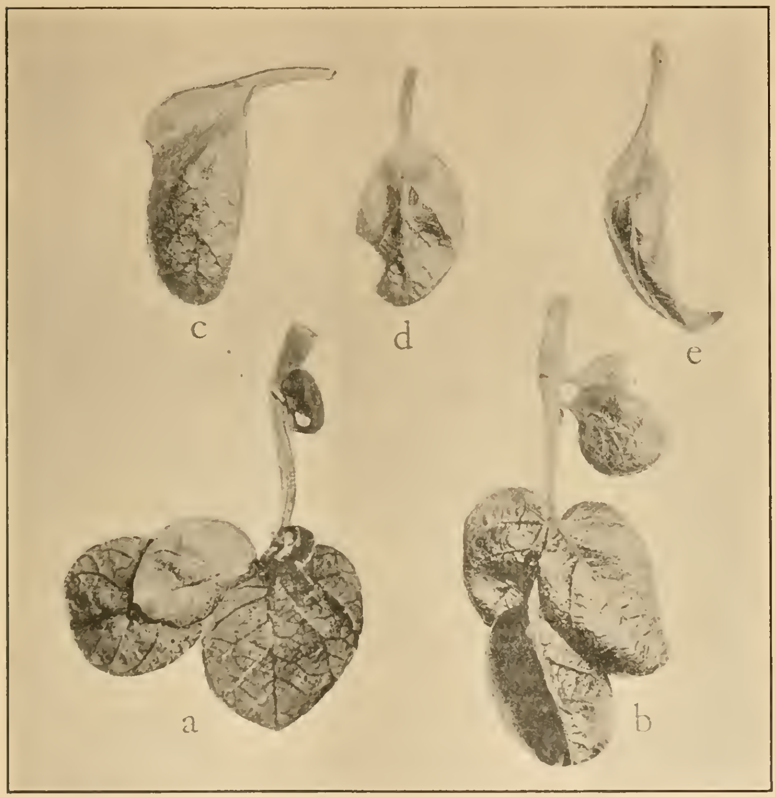

FIG. 3. a, b, Abnormal leaves from second-growth lateral catkin; c, d, e, leaves associated with abnormal catkins.

When such flowers develop into nuts, the latter retain the peculiar form and surface characters, as shown in figure 1, b and c. This is the most common form of abnormal nuts. Over fifty have been picked up from beneath one of the fifteen trees upon which such nuts have been known to mature. But most of the fifteen produced only a few such nuts on each tree. Altogether the writer has about two hundred which will be planted in January, 1910.

Abnormal leaves have been observed in two situations: at the base of the second-growth lateral branchlets, and, occasionally, associated with the abnormal catkins already described. Abnormal leaves from a second-growth lateral branchlet are shown at a and b, in figure 3. Leaves associated with abnormal catkins are shown at c, d, and e, in the same figure.

Some of these leaves are similar to the typical leaves of an anomalous form of Juglans, described and illustrated in Jepson's "Silva of California," and referred to therein as the "original fertile tree." This is one of twenty strange trees that appeared among the progeny of a single wild walnut tree which has since been destroyed. On account of certain leaf characters and their general appearance they have been known as "walnut-oak hybrids." Now the fact that the peculiar leaves above mentioned are associated with the abnormal flowers, at once suggests the possibility that the original fertile tree and similar anomalous forms of Juglans may have grown from seeds produced by such abnormal flowers. Other observations of the writer make this possibility appear even probable. These anomalous trees have not been known to be produced from the normal nuts of *Juglans californica*, although they have been extensively planted during recent years for horticultural purposes. Second-growth flowers have been found on several of the anomalous trees. Also, during the normal blooming period they frequently produce bisexual flowers and, whether bisexual or not, the flowers often have peculiar external markings on the ovary resembling those already noted in the teratological flowers of *Juglans californica*.

Finally, it should be mentioned that similar anomalous forms have appeared among the progeny of other native black walnut trees in southern California. Unless they developed from flowers of the normal crop, which does not seem likely, then in all probability they did come from some such teratological flowers as those described in this paper.

We have noted the occurrence of teratological flowers, fruits, and leaves, which not only exhibit very interesting characters, but also appear to be worthy of further study when reviewed in the light of the following considerations: (1) The fact that they were of frequent occurrence in 1909 among the walnut trees in Brea Canyon,thus indicating either some general external factor or an unstable condition in a certain proportion of the individuals of the species. (2) The probability that trees grown from seeds produced from the abnormal flowers will have characters strikingly different trom those of *Juglans californica* particularly in their leaves and habit of growth.

PLANT ASSOCIATIONS OF THE DESERT LABORATORY DOMAIN AND ADJACENT VALLEY.*

By V. M. Spalding.

Tumamoc Hill, on the northern slope of which the Desert Botanical Laboratory of the Carnegie Institution of Washington is situated, is an outlying peak close to the eastern slope of the Tucson Range, which latter extends from the neighborhood ot the old mission of San Xavier del Bac, south of Tucson, in a general northwesterly direction upwards of 25 miles, parallel to the valley of the Santa Cruz River. Its geographical position and topographical features are alike favorable for an investigation of factors by which the distribution and present associations of plants here represented have been determined.

Standing, as it does, on the border-land between the plateau region of central and eastern Arizona, on the one hand, and the great desert plain that stretches westward to the Colorado River and its delta, on the other; connected, moreover, by the valley of the Santa Cruz and by broken ranges of mountains and hills with the highlands of northern Mexico, there mingle within the narrow limits of this one hill and the adjacent valleys many plants represented in the widely different floras of California, New Mexico, and Texas; and along the north and south pathway in which it stands may be noted the northern limit of various Sonoran species, as they drop out one by one. Its altitude, slightly upwards of 3,000 feet, gives at this latitude, in connection with its topographical features and variety of soils, an ensemble of conditions under which plants of very different habits occur together; well-marked mesophytes, for example, growing luxuriantly in close proximity to the most pronounced types of xerophytes. Thus, as regards historic, edaphic, and climatic factors, the tract selected offers exceptional advantages for studies of local distribution.

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*Reprinted in part, with revision, from Publication No. 113 of the Carnegie Institution of Washington.

The fact that Tumamoc Hill owes its origin to volcanic agencies, intermittently active from the Tertiary to within Pleistocene history, fixes the period within which its flora has become established. During the whole of this period, if we accept the views of present day geologists, generally arid conditions have prevailed throughout this region, except at higher altitudes. So far, then, as available evidence goes, the desert plants now growing here originated in their present places or came to them as desert plants; there is no evidence that they became such after their arrival; and taking them as we find them,we are under the necessity of emphasizing the efficiency of existing agencies as factors in their present actual distribution, without invoking other causes to explain phenomena traceable to those now in operation.

It is a matter of congratulation that the existing flora has been so little disturbed or modified by human agency. The few introduced weeds, though in some cases conspicuous, have made little real impression upon its character, and there is no evidence that extermination of species has followed the occupation of Tumamoc Hill by the prehistoric people the outlines of whose dwellings are still distinctly traced upon its summit, nor even through the ruthless work of modern quarrymen, by which its sides are here and there marred. Changes due to human agency have undoubtedly occurred, and are seen most plainly along the various trails and wagon roads that have been constructed; but there is no reason to suppose that thus far they are of more than the most superficial character. Certain changes are beginning to follow the fencing of the reservation, coincidently with the exclusion of hunters and cattle; but the flora in all its essential features, as it now exists, is presented to us as the final phase, thus far, of the natural movements and adjustments that have been taking place, broadly speaking, since early Pleistocene times.

It can hardly be doubted that in this region, during the period from the Tertiary to the present, two distinct floras of different origin have existed side by side as they do today; the one including the desert plants of the arid plains and lower elevations, the other the mesophytes of the mountains. As just stated, the species belonging to the former have apparently originated where they now live, or at least have undergone migrations of very limited extent compared with those which many of the latter have made as representatives of plants which in earlier days migrated southward from the arctic regions, and which still, at the present time, exhibit features of the old Eurasian stock. There is, of course, more or less intermingling of the elements of these very diverse floras, where climatic and soil conditions make this possible, but one has only to place side by side the plants of Tumamoc Hill and those of Mount Lemmon, a few miles away, to realize how essentially different in their fundamental characteristics the two floras are.

In dealing with the former, it is found that with it are closely associated, though in more or less distinct contrast, the plants of the neighboring valleys, and it has seemed necessary, therefore, to include with the Laboratory domain the natural setting of Tumamoc Hill, that is, the ground immediately adjacent, extending from the bed of the Santa Cruz River on the east to the boundary of the Laboratory reservation on the west, and from the flood-plain of the river on the north to the same topographic horizon on the south, in this way delimiting the area studied by natural rather than artificial boundaries. Thus bounded, this area includes approximately 4 square miles and exhibits all of the characteristic plant associations within the immediate neighborhood of the Desert Laboratory.

(1) THE RIVER AND IRRIGATING DITCHES; ASSOCIATION OF HYGROPHYTES.

The Santa Cruz River has the general character of streams in the Southwestern United States. For months at a time its bed is empty, but at the period of summer and winter rains it is not infrequently filled with a raging torrent which has measured no less than 4,012 cubic feet of water per second at the Tucson bridge, flowing at the rate of 9 feet per second. When thus swollen by rain it is a turbid, impetuous stream, bearing along branches of trees and debris of various kinds to be deposited at different points as the water lowers. At these times of flood its power of erosion is very great, and in the course of a few hours the banks in places are deeply cut away, acres of fertile land being swept into the devouring current.

In the course of a few days a small and harmless stream, a few inches in depth, is quietly flowing in its channel, and later, after the rains are over, even this disappears, leaving the bed of the river, as far as appears on the surface, only a collection of variously assorted and mingled masses of sand and gravel. Beneath the surface, however, is still at some depth a body of water, and from this, even in the driest times, the cottonwoods and willows along its banks draw an abundant supply (Fig. 5).

From what has just been stated, it is evident that the conditions are in general unfavorable for the growth of aquatic vegetation. The rapidity of the current when the river is "up", the turbidity of the stream, and the long period when no water appears above ground, are not conducive to the normal development of water-plants. Yet there are places where these do secure a foothold and grow with remarkable vigor. Especially is this true of the irrigating ditches, in which green algæ frequently accumulate in such quantities that they have to be cleaned out to prevent the channels from becoming choked. Great masses of *Cladophora* are often thrown out on the banks for long distances. *Hydrodictyon* is also abundant. *Potamogeton pusillus* is frequently conspicuous, and in pools of the river channel, where the force of the current is lessened, the water-cress (*Radicula Nasturtium-aquaticum*) grows in luxuriant masses.

(2) THE RIVER BANKS; ASSOCIATION OF COTTONWOODS AND WILLOWS.

The banks of the river are lined with willows (*Salix nigra*) and cottonwoods (*Populus Fremontii*), which constitute their conspicuous vegetation, while the arrow-weed (*Pluchea sericea*) is of frequent occurrence. Another plant conspicuously present where the banks are sandy is *Aster spinosus*, which also extends out on the flood-plain to some distance. As in similar situations elsewhere, a considerable number of annual plants succeed in gaining a foothold on the shifting sands of the river, but none of these are distinctively characteristic of this special habitat. It is the cottonwoods and willows that constitute the typical vegetation of the river-banks. It may be noted in passing that the willow of the Santa Cruz River does not appear to be specifically distinct from *Salix nigra*, which ranges from New Brunswick to Florida and westward to California. The cottonwood (*Populus Fremontii*), according to Bray, apparently takes the place of *Populus deltoides* west of the one-hundredth meridian, extending to western California and into Lower California and northern Mexico.

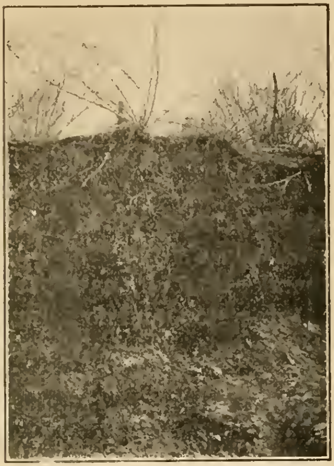

FIG. 4. Roots of mesquite exposed where erosion of the banks of the Santa Cruz River has taken place.

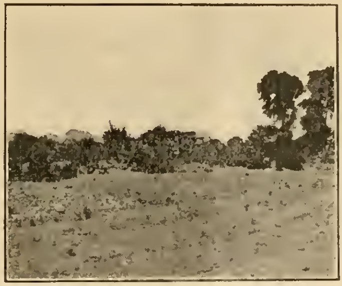

Fig. 5. Dry bed of the river at Tucson. Willows and cottonwoods its banks.

The flora of the river and its banks is seen to be meager as compared with those of regions with abundant rainfall. In the Huron River, at Ann Arbor, Michigan—a fair example for the eastern United States—there are over a dozen species of *Potamogeton* as against the single species of the Santa Cruz River at Tucson, and while along the banks of the Huron River, at the place named, there are 10 or more species of willows, we have on the banks of the Santa Cruz, at this point, but one or two. It is evident that the total of conditions here is unfavorable to the great majority of species of similar habitats in humid regions, and with the admirable arrangements for dispersal which these plants possess, it is not unlikely that various species have been brought here time and again that have thus far failed to gain a permanent foothold. It is quite probable, however, that various species not found here would thrive if they could once get a start. Seeds of willows, for example, may often have reached the river when there was not sufficient moisture in its bed to result in their germination, and even when started they would still find conditions far less favorable for survival than along the banks of streams in regions of abundant rainfall and more humid atmosphere.

In its physical features, then, and in its flora (and fauna as well) the Santa Cruz is a characteristic river of the region through which its course runs. However luxuriant may be the growth of the few species that have established themselves along its banks, and however its waters may locally be choked at times with dense masses of one or more aquatic species, yet as regards both physiognomy and life it is essentially a river of the arid Southwest, presenting the same general characters as those of the Salt River, the Gila and others of this region, and no botanist would for a moment fail to recognize this fact, especially as just beyond its banks there is growing on every hand the mesquite, the everywhere-present species of the Lower Sonoran zone.

Thus even an abundant water supply, with the strong growth of hydrophytes determined by it, altogether fails to reproduce here, except in the most superficial way, the plant associations of rivers in the eastern United States. There may be an approach to the mesophytic forest, where willows and cottonwoods grow thick along the banks of the Santa Cruz, but not a mesophytic forest of the East or North. Other factors than the water supply, however potent this may be, are to be reckoned with in attempting to account for the wide differences of plant and animal life that are here observed.

(3) THE FLOOD-PLAIN; MESQUITE FOREST ASSOCIATION.

The flood-plain of the Santa Cruz River is essentially the same in its physical characteristics as those of other rivers of the Southwest. A deep,fine alluvium, closely resembling the Maricopa sandy loam of the Gila and Salt River Valleys, the product of a long period of erosion and deposition, fills the valley from the river-bank to the mesa-like slopes at the foot of the mountains. It approaches adobe in texture, and bricks of a rather inferior quality are manufactured from it, but it is of a high degree of fertility, as is evidenced by the crops of grain, fruits, and vegetables which it produces.

As already stated, the flood-plain in the immediate vicinity of the river suffers from erosion when the stream is high. Figure 4 shows the condition of affairs at a point less than a mile south of Tucson, where the roots of mesquite and other plants have been exposed along the deeply cut channel.

According to statements of residents, this extensive erosion is of recent date. Previous to the advent of cattlemen some 20 years ago, and the destructive effects of over-pasturing, the valley of the Santa Cruz had a luxuriant growth of saccaton and other vegetation, which prevented the cutting of channels, and the water spread out over the whole valley instead of flowing through the deep cuts it has since made; tules grew thickly in the springy places, and a fine forest of mesquite covered the ground. At present the effects of such erosion are seen most plainly from a point below Tucson to one about 2 miles above the city. It is inevitable that such changes, where they occur, should be followed by a lowering of the water-table of the flood-plain, resulting in more or less pronounced changes of vegetation. Nevertheless, although the formerly abundant saccaton has disappeared, and along with it doubtless other species, the vegetation of the flood-plain shows clearly enough what were in earlier times, and are still, its essential features.

The dominant species is the mesquite (*Prosopis*), here in the form *velutina*, a highly characteristic species of the Lower Sonoran zone as defined by Merriam, but extending in its various forms far beyond. It is by preference a plant of low flats, though it occurs far beyond these on the uplands in situations where a sufficient water-supply is obtainable. In the neighborhood of Tucson the mesquite ranges in size from a mere shrub a few feet height of a tree 2 feet or more in diameter and upwards of 40 feet in height. Such trees grow thickly on the bottom-land near the old mission of San Xavier, forming the fine forest that stretches for miles up the river, in the shade of which grows a rank vegetation similar to that of eastern mesophytic forests in luxuriance.

The habits of the mesquite are popularly well known, and its presence is taken to indicate a good water supply. Its roots extend widely, to a distance of 50 or 60 feet according to credible observers, and possibly to a corresponding depth; and when cut green its wood tissue, which is hard and heavy, carries a large percentage of water, precisely as do the hardwoods of the eastern United States, and strikingly different from the creosote bush, its near neighbor on the slopes beyond the flood-plain. At the same time, the general structural peculiarities of the mesquite are xerophytic. It is commonly armed with spines, and its coriaceous leaves are well protected against excessive transpiration. It is a plant requiring a better supply of water than many of its associates, yet well adapted to the low relative humidity of the desert air, and its occurrence beyond its own special area, ranging as it does to the top of Tumamoc Hill, in spots where a soil retentive of moisture affords the conditions it needs, corresponds with this peculiarity. Thus it is, in a sense, a desert plant, yet one of high water requirement—characteristics which it shares with various other species.

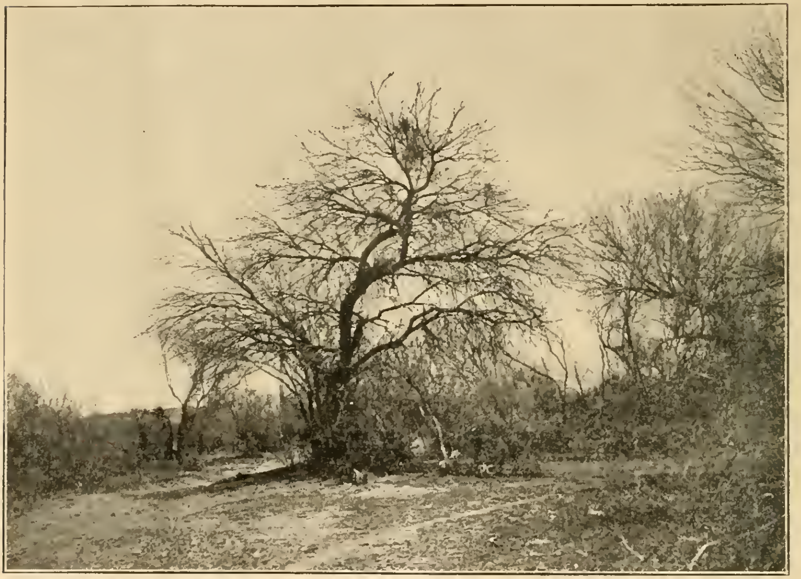

FIG. 6. Edge of mesquite forest near Tucson.

The capacity of this plant for taking possession of wide areas beyond its earlier limits of distribution is of special interest.

According to Bray, "its spread northward and eastward from the Rio Grande country during the past 50 years has been a marked phenomenon. By its invasion, mile after mile of treeless plain and prairie have been won and reduced to a characteristic orch-like landscape. It has traveled northward over the Staked Plains, covering half their area, and has passed over Oklahoma and into southwest Kansas. This encroachment of mesquite is partially accounted for by its weed-like capacity for occupying new ground . . . and by the influence of cattle in scattering the beans." Such extensive and rapid invasion as are here described has not been observed in Arizona, so far as the writer is aware, but the same characteristics are noted here—its preference for low, flat areas, with compact soils, but with a marked capacity for extending beyond these on to higher ground, its successful reproduction where it is really at home, and the tenacity with which it holds its place where once established. Its endurance of conditions to which various other species are less fitted is well seen in many places from Texas to California, and particularly in the Salton Basin, where great mounds of sand are blown about the mesquite, which keeps on growing, its branches extending beyond the rising heap or dune, until the

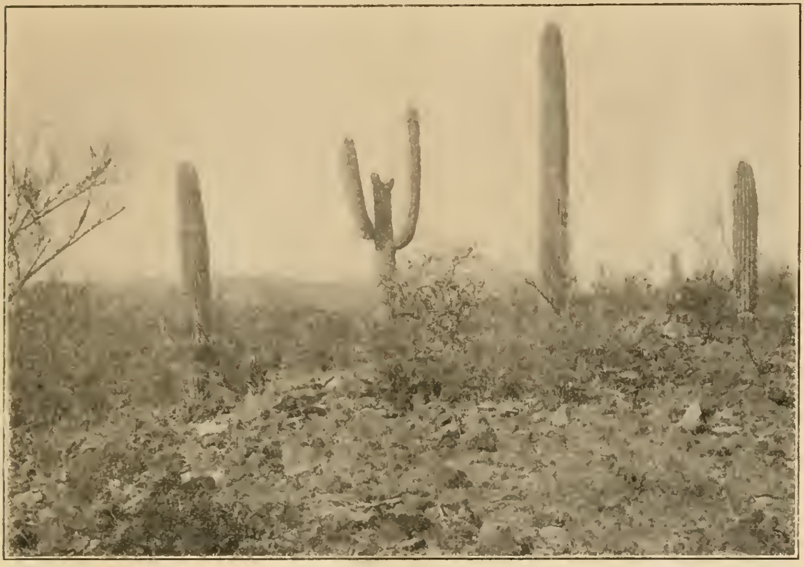

Fig. 7. Vegetation of Tumamoc Hill; sahuaros, opuntia and palo verde conspicuous.

latter has reached a height of several meters, the protruding branches still covering it with an apparently healthy and normal growth.

All in all, in the success with which its relatively rapid dissemination is accomplished, in its ready adjustment to widely varying conditions, its utilization of available water, and in other ways, this plant is to be considered one of the best adapted of our desert species, and its wide distribution and present successful invasion of new areas mark it, not as a decadent species, but as one in pristine vigor, from which apparently several others are in process of evolution.

Associated with the mesquite are a number of characteristic species, some of which are confined to the flood-plain, while others extend with it beyond these limits. Of the latter *Acacia constricta* is a conspicuous representative. Its habits are essentially those of the mesquite as to water requirements, and it closely resembles this species in its xerophytic structure. The two grow side by side near the river and to the summit of Tumamoc Hill, in precisely the same situations, one being, apparently, the ecological equivalent of the other. Other species behave differently. *Acacia Greggii* grows with the mesquite in its lower range, but not on the hill above, and the same is true of *Condalia lycioides*. Both of these exhibit distinctively xerophytic structures, but both are as yet adapted to a somewhat more restricted range of soil conditions than are the mesquite and *Acacia constricta*. *Sambucus* and *Fraxinus velutina*, also of this association, are still more limited in their range, growing near irrigating ditches, hardly affecting even the edge of the mesa-like slopes, and structurally are to be thought of as essentially mesophytic.

Passing through the list of plants belonging to this association, it is seen that the same relations are maintained—certain species are strictly confined to the flood-plain, while others occur rather widely beyond it; it is to be noted, however, that even those that range most freely exhibit their best development on the flood-plain and not on the hillsides. The mesquite, which attains the size of a tree on the plain, is a mere shrub on the hill, and *Bigelowia Hartwegii*, which grows with the luxuriant habits of a weed in the former situation, is scattering and small in the latter.

It appears, then, that the flood-plain is the natural habitat of a number of species, many of which are incapable of successful growth elsewhere, while a few grow fairly well, but not at their best, under different conditions beyond these limits. Taken as a whole, the plants of the flood-plain find there their real home, and they exhibit—such of them, at least, as have been carefully observed with reference to this—a striking conformity of the root system to the peculiarities of the soil in which they are growing. This, as already stated, is of fine texture, retentive of moisture, and of great depth, with the water-table varying in level, but apparently never beyond the reach of the long tap-roots of the mesquite and *Acacia*.

The root-system of these plants consists of a tap-root which grows rapidly downward, and when developed is always within reach of a permanent, deep water-supply, and a system of widely-spreading lateral roots which are in relation to more superficial layers of the soil. Thus the plant is admirably fitted to absorb water largely from the upper layers when these are moist, and at the same time, and also in times of drought, without any interval of precarious supply, to draw on the deeper sources below. The contrast between this and the shallow root-systems of many of the great trees of eastern mesophytic forests, familiar to everyone who has seen them up-rooted by heavy winds, is highly instructive. There is little wonder that the mesquite and *Acacia constricta* have tenaciously held their places through all vicissitudes and promise to be dominant in their habitat until actually rooted out.

There are evident movements of vegetation now taking place within this association. *Bigelowia Hartwegii*, a native weed, has spread with wonderful rapidity under the mesquite within the last three years of favorable seasons; and other species, both weeds and useful plants, have been brought in at various times and by different agencies to such an extent as to give to the vegetation, in places, a distinct change of character. It should be added that *Bigelowia* (and presumably other low-growing plants of the flood-plain) has a far less extended root-system than the mesquite, obtaining water from relatively near the surface. If the root-system does not reach to the water-table, and this can hardly occur, it would seem that this plant, and others of this association of the same physiological class, must be more xerophytic in habit than the mesquite. It seems that the flood-plain may be thought of as the home of two quite different sets of plants, one with a tap-root and its branches reaching the water-table, and the other depending upon the water contained in the upper layers of soil; the former approaching mesophytic, the latter more definitely xerophytic habits.

(*Continued to March number.*)

FIRE AS A BIOLOGICAL FACTOR.

By J. C. Blumer.

It is a trite but truthful saying that fire is both a useful servant and a dreadful master to man in all walks of life. The prairie farmer made extensive use of it in the early days, at the risk and cost of property and even human life. As a forest fire it has been a much more dreaded destroyer. It is today the most destructive enemy of the forest itself, yet bids fair to become, in certain parts of the West, at least, the forester's most effective aid. As some years ago suggested by the writer for certain high parts of Colorado forests, Mr. E. H. Frothingham now advocates the burning of the humus as a means of reforestation for the dense Pacific Coast forests of Douglas fir. The argument often advanced in favor of fire protection that fire destroys the humus cover, is thus to some extent invalidated. Humus, even without forest cover, may still do important service as a watershed cover in the conservation of moisture; but it is becoming clear that, especially in the coast forests and forests of high humus-content generally, destruction of the humus by fire is necessary if the establishment of a young forest is to be successful in the broadest sense of that term.

Fire is also important from the phytogeographer's viewpoint. It may have been a factor of far-reaching importance in the establishment of the prairie sod of the Mississippi Valley, the distribution of species, and composition of the societies of its grassy flora. Over the entire Rocky Mountain region it would probably be difficult to find a single square mile of forest that does not show signs of invasion by fire at some time in its history. Many areas can be found that have been razed repeatedly within the history of the passing forest generation. This is conclusively proven, almost to the exact date, by counting the annual rings in old, fire-scarred trees. Unquesionably fire has been and is a most potent factor in disturbing the more or less well-established equilibrium among forest societies, and especially among the members of such societies. Invasion, succession, and re-establishment of equilibrium take place each time upon the virgin and sometimes practically sterile soil left by a very destructive fire. The character of these processes is determined by the severity of the fire, the degree of fire-resistance of the species, the productive, locomotive and propagative qualities of the surviving species on the ground, or in the vicinity, efficiency of wind and other carrying agencies, and the fighting qualities of the offspring with, or fitness to, conditions of their immediate environment on the one hand, and the members of their own or associated species and generations on the other. This may be expected to apply not only to forest trees, but to shrubs, herbs, and all the lower orders of the plant kingdom, even down to the bacteria, both parasitic and of the soil. The new societies may thus be very different from their predecessors. In the case of the Douglas fir, a single characteristic, namely, its notably high fire-resistant powers, probably due to its thick, non-inflammable bark, in the course of ages may have had a far reaching influence in the determination of its enormous range and present prominent status in a large number of West American forest associattions.

While not excusing carelessness in handling fires it may be said with good reason that many of the forest fires for which responsibility has been attributed to man, have been originated by lightning. Observers have not infrequently noted fires being started in the forest by the discharge of atmospheric electricity during thunder showers,and trees showing the scars of a bolt are often found badly burnt. However, in this as in many other directions, Nature provides her own check to destructive forces. If it were not for the fact that the most violent disruptions are usually followed by falling rain, and resulting fires thus extinguished, forest fires originating from this cause would unquestionably be much more numerous and destructive. Also, the fire damage in mountainous regions is lessened by the fact that the discharges are largely concentrated upon trees on high ridges and exposed peaks. As fire will not readily spread down hill under any conditions, and as it gathers its most destructive force in ascending a slope, the burnt areas will be limited. Out of one hundred pine trees (*Pinus arizonica*) examined in order as they stood along a certain high ridge in the Rincon mountains of Arizona, in October, 1909, nine or ten were found to have been struck by lightning at one time or another, and a number were severely burned. In other more exposed places the damage was much greater, and a certain high point in the Santa Ritas showed perhaps as high as thirty to fifty per cent of the trees as having been struck by lightning, while many were also severely scarred by fire. During the rainy season of summer these mountain peaks literally become the lightning conductors of the desert, and the forest growth is often seen to suffer heavily from mechanical disruption by frequent bolts as well as by resultant local fires.

Tucson, Arizona.

BOOKS AND CURRENT LITERATURE.

Peat Deposits of Maine, by Edson S. Bastin and Charles A. Davis, has been issued as Bulletin 376 of the United States Geological Survey,bearing date of 1809. It is accompanied by a map of Maine, showing localities where peat has been found in important amounts. Between forty and fifty such localities are marked, nearly all of them in the southern half of the state. The northern part doubtless may be expected to make a far better showing when it is more fully explored. The conditions of peat formation, the plants concerned in its growth, the variable character of peat deposits,and the present floras of peat bogs are among the subjects of botanical interest. On the economic side there are discussions of location, market, methods of prospecting and estimating, the choice of machinery and the utilization of the product. About one-half of the paper is devoted to detailed descriptions of localities, with maps giving the location and areas of the bogs examined, and the locations of test borings, thus presenting a body of exact information indispensable to those who may engage in further investigation or in the exploitation of the resources described.

A highly interesting account of the new flora of Krakatau is given by Professor D. H. Campbell in the *American Naturalist* for August, 1909. The extraordinary volcanic eruption which occurred in the Straits of Sunda in August, 1883, resulted in the total obliteration of the luxuriant vegetation of Krakatau, even the dense forest which extended to the summit of the highest peak being completely covered by a deep mass of hot ashes and pumice. Since the whole island was thus efficiently sterilized, and was comparatively isolated, a unique opportunity was presented for studying the re-establishment of vegetation on an extended and absolutely barren area.

The first botanical expedition for this purpose was made in 1886 under the direction of Professor Treub, so long in charge of the botanical gardens at Buitenzorg, Java It was found that during the interval of three years which had elapsed since the eruption, a considerable number of plants had already established themselves upon the island. Conspicuous among flowerless plants were the blue-green algae, the slimy films of which, coating the surface of the ashes, formed a favorable substratum for the germination of spores and the seeds of a few phanerogams. The preponderance of ferns in the new flora was particularly marked, no less than eleven species being found. Fifteen species of phanerogams had established themselves, but they were far less numerous in individuals than the ferns.

A second expedition, also under Treub's direction, was made to the island in 1897. During the interval of something over ten years since the first visit, the number of plants had greatly increased and characteristic associations had already begun to be formed. The total number of vascular plants amounted to sixty-two, of which twelve were pteridophytes and fifty phanerogams.

A third party visited the island in 1905, and in the spring of 1906 a visit was made to it by Professor Campbell, Professor A. Ernst of the University of Zurich, and several others. For these various expeditions the results so far published give a total of 137 species established on the island, of which a very large majority are phanerogams. The preponderance of ferns noticed in the earlier expeditions had been lost, only six species of ferns and one of Lycopodium being collected on the last visit. There is now a remarkable scarcity of bryophytes. Two species of mosses, but no liverworts, were found by Dr. Campbell, and three species of fleshy fungi have been collected.

It appears that the earliest immigrants, bacteria, blue-green algae, ferns and mosses, were wind borne, and the same is probably true of the first phanerogams found upon the island, namely composites and grasses; but later arrivals have been due in all probability in a large measure to ocean currents, though birds have doubtless played a part in bringing fleshy fruits, such as those of Vitis and certain species of figs. The forest has developed so rapidly that it is to be expected that it will soon cover the island again, as it did before the catastrophe of 1883.

In a second installment of notes on introduced plants of Southern California (Muhlenbergia, Oct. 23, '09), S. B. Parish gives an account of the migrations of prickly lettuce (*Lactuca scariola* L. var. *integrata* Gren. and Godr.), the Russian thistle (*Salsola kali*, var. *tenuifolia*) and a number of other weeds, the progress of which he has watched for some twenty years. The interesting fact is recorded that certain weeds, such as *Daucus carota* and *Datura tatula*, for example, which are very aggressive and wide-spread on the other side of the continent, have maintained their foothold only for some years in Southern California and have finally disappeared. As noted by Dewey, prickly lettuce, which in the prairie states was recognized as the most aggressive pest with which the farmer had to contend, is now becoming much less abundant in regions where it formerly occupied nearly all of the waste land and many of the cultivated fields, and the individual plants are generally less robust and less prolific than they were six to ten years ago. The frequency with which this history is repeated in widely distant habitats indicates something of the exacting requirements which must be met in the successful invasion and establishment of weeds which in earlier years of their growth threaten to overrun the region into which they have been introduced.

J. C. Blumer, in a recent issue of *Science*, presents a clearly drawn picture of the plant geography of the Chiricahua mountains of southeastern Arizona, from which it appears that the tree growth of these mountains is quite similar to that described by Mearns for a number of ranges of the nearby international boundary.

The lower Sonoran zone, characterized by cacti and thorny shrubs, touches the Chiricahua mountains only at their eastern base and both ends. The upper Sonoran completely encircles them in a broad belt of evergreen brush land with oaks as leading species, extending well into the transition zone, and there mingling with the outposts of the coniferous forest which envelopes all the remainder of the range with a mantle of needle-leaf evergreens.

The influence of aspect on local distribution is strikingly shown, especially where, as in the case of two contiguous slopes near Paradise, one faces north and the other south. The north slope in this case supports a dense shrubby growth of Ceanothus, Cercocarpus, and various other plants, from which grasses are practically absent; while the south slope is entirely destitute of trees and shrubs, and is covered with grasses.

In regard to the influence of soil, it is shown that each division or group of plant societies is peculiar to a class of rocks and residual soils of its own, and, further. that the so-called tension lines between these societies or groups of such are usually marked with great definiteness, and bear no relation to aspect. Cases occur in which, if two quadrats of one thousand square feet each were laid off, each on a separate formation, but adjoining one another on one side and on the contact line, not a single woody species would be common to both quadrats, although several such might be found on either one.

The paper, embodying in condensed form the results of long continued and exact observation, is a definite contribution to our too limited knowledge of the factors determining the local distribution of plants in the arid Southwest.

J. Y. Bergen, in the *Botanical Gazette* for October, 1909, gives an account of transpiration experiments with young seedlings of Cucumis, Ipomoea, Mirabilis, Phaseolus and other annual plants. It is shown that as a result of being grown in a humid atmosphere, all the plants studied acquire a much greater than normal capacity for transpiration in a moderately dry atmosphere, but that different families and different genera of the same family vary greatly in their capacity to acquire by such culture a tendency to extremely rapid transpiration.

The Distribution and Movements of Desert Plants, by Volney M. Spalding, has been issued as publication No. 113 of the Carnegie Institution of Washington. The first part is devoted to a consideration of the plant associations and habitats of a restricted area in which the domain of the Desert Laboratory at Tucson, Arizona, is situated.

The second part discusses the local distribution of certain species on this area, and includes comparative observations made in other parts of the Southwest. In this division of the work an attempt is made by means of exact mapping of the distribution of important species on restricted areas, by numerical data, and by determination of the value of certain physical factors, to arrive at conclusions regarding the causes underlying the most obvious facts of distribution, such, for example, as the marked differences in choice of habitat manifested by the mesquite and creosote bush, the several species of palo verde and others. The percentage of available soil water, temperature relations, determined in part by aspect, amount of alkali in the soil and the capacity of the latter for aeration, are named as determining factors. The correspondence between topographic features as the result of physiographic processes and the local distribution of plants is strikingly brought out in the comparative studies, especially those conducted in the Gila Valley. No less important are the observations of the close correspondence between different rock formations and the well-marked plant societies supported by them, as recorded by Blumer in his studies of the Fort Bayard (New Mexico) watershed, in which, within a comparatively limited area, no less than seven distinct societies of plants, each referable to its special rock-formation, are clearly recognized and described.

The section on invasion, competition and succession includes records with maps showing the exact present position of certain invading species, thus recording in permanent form the data for future comparison. There is abundant evidence that within the area under consideration severe competition prevails between many of the plants, notwithstanding the generally received view that with desert plants the struggle for existence is almost exclusively with their physical environment rather than with each other; a view, it is to be said, which approaches the truth the more distinctively arid are the prevailing conditions. Thus in the zone of the creosote bush, where really desert conditions exist, competition between species is reduced to a minimum, and the struggle with environmental factors really determines the outcome. Well-marked successions of permanent character, corresponding with changes of topography, are readily observed. In the cases described an essential change of topographical boundaries has been promptly followed by the advance of certain associations into an extension of their appropriate habitats.

In the third part of the work, devoted specifically to environmental and historical factors, there are discussed in order the geology (by Professor C. F. Tolman), soils (Dr. B. E. Livingston), climatic conditions, and animals of the Desert Laboratory domain. The data are too numerous for reproduction. It is sufficient for the present purpose to state that in various particulars, especially as regards soils, and atmospheric conditions, some of the most striking facts of local distribution are correlated, with a certainty equivalent to demonstration, with factors which stand to them in a causal relation.

The section on vegetation groups of the Desert Laboratory domain, contributed by Professor J. J. Thornber, shows that of the 449 species listed no less than 264 are limited in their distribution to the southwestern United States and Mexico, in other words, at least 59% of this flora as it exists today is to be thought of as belonging distinctively to the desert region of Southwestern North America. With regard, therefore, to the geographical origin and movements of the plants here represented it may be assumed that a large contingent of Sonoran species had its origin in the immediate region, some of them possibly on the very ground of the Desert Laboratory domain. Certain other species, relatively few in number, belong to genera which exhibit their greatest morphological differentiation and most numerous representation in the Northwestern and Western United States. Still other plants have a history interwoven with the geology of Western America, which at present can only be stated in general terms. At a relatively early day, possibly not later than the Pliocene, there seems to have been a continuous highway, from Southern Mexico, along the Isthmus of Panama, southward to Argentina and Patagonia, by which the creosote bush, various cacti, yuccas, and members of other groups represented on the Laboratory domain at the present day, made their southward journeys. In the northern hemisphere the later advance of the great ice sheet in the Pleistocene drove southward many plants, some of which are found today on Tumamoc Hill, but in general they have made the mountains their pathway and also their home, and their minor movements can not well be traced.

Of this paper as a whole it may be said that the study of local distribution has been carried far enough to warrant a number of important conclusions. It was evidently the purpose of the author to lay the foundation for a broader study by as exact and thorough an investigation of a restricted area as could be made, and in the carrying out of this undertaking he has been fortunate in associating with himself a number of collaborators whose work has furnished data of permanent value; but the wider field, indicated by the title of the paper, still remains, in great part, to be worked.

NOTES AND COMMENT.

We greatly regret the occurrence of several mistakes in the article by L. R. Waldron on "Heredity in Populations in Pure Lines," in the January number of the PLANT WORLD, due to the fact that proof was not submitted to the author. The errors to which reference is made are to be corrected by the omission of "in" before "breeding," middle of page 8, and by the omision of "not" in the last sentence of the first paragraph on page 9, and also from the sentence next to the last in the fololwing paragraph.

With the increased attention now being paid to the utilization of neglected natural products it is of interest to note that peat, which has been almost wholly unused in the United States, now seems likely to prove an important source of heat and power. Among papers published by the United States Geological Survey in 1909 is the one on the Peat Deposits of Maine already referred to in this issue, and another on the *Peat Resources of the United States*, by Charles A. Davis. From this latter paper it appears, using the author's estimates, that reckoning eight per cent of the total area of swamp land in this country to bear peat beds averaging nine feet deep, the aggregate is 11,188 square miles, with an average possible production of 200 tons of dry fuel per acre-foot, or a total of 12,888,500,000 tons, and that this quantity of peat at three dollars per ton in the form of air-dry blocks would have a value of $38,665,700,000.

Such a possible value, which appears to have been conservatively estimated, amply justifies the investigation of peat deposits which has been undertaken by the U. S. Geological Survey. It was also to be expected that capitalists and others interested in the natural resources of the United States would take up the subject with a view to ascertaining what there is in it. A peat society has been organized, and a new peat journal which has reached several issues gives promise of a vigorous and useful existence. Evidently an economic factor of very considerable importance is beginning to receive wide attention.

The whole history forms a chapter in the march of events that is highly instructive. A few years ago, with the development of ecological ideas, peat bogs were found to be very satisfactory objects of study on the part of young botanists, owing to their striking features, the sharp delimitation of their societies, and the comparative ease with which much of their history is capable of being deciphered. Then, too, they connected past geological events with an entirely modern set of conditions, and gave the hopeful investigator—or his instructor—an opportunity to theorize without incurring much risk. Naturally enough, the study of peat bogs has had a sort of perennial interest up to the present day, and from the papers of all grades of merit that have appeared on this subject in the botanical journals no little material of considerable value has accumulated, *i. e.* facts of potential value in the hands of the seer whose coming in the realm of ecological inquiry is to be most earnestly hoped for.

Into the midst of this rather slow development of academic or purely scientific ideas the capitalist has finally projected himself, as in so many similar cases, and he is welcome! We already know many times as much about the things in peat bogs that are really worth investigating from a scientific standpoint, as we should have known if it were a matter of no economic importance. The explorations, excavations and analyses that have been made within the last two or three years have been made possible through the cooperation of people of means with men of the necessary training. Each has been idnispensable to the other, and results that are of much importance from the viewpoint of each are beginning to be realized. It is hoped that some of these may be given to readers of the PLANT WORLD in a later issue.

Volume 13 Number 3

THE PLANT WORLD

A MAGAZINE OF GENERAL BOTANY

MARCH, 1910

THE BOTANICAL GARDEN OF THE UNIVERSITY OF AMSTERDAM.

BY F. M. ANDREWS.

The first botanical garden in the city of Amsterdam, Holland, was situated near the Amstel in 1630. Doctor Joannes Suippendal, a botanist, used to give lessons in this garden. With the increase in size of Amsterdam the garden was moved to a new part of the city. The plants were kept for a few years in the garden of the Gasthuis till the new garden was ready, which was in 1683. This garden was governed by many rules. In 1683 an admission fee of four stuivers (about eight cents, U.S. money) was charged to defray the expenses of the garden. Some people were exempt from the payment of entrance fees, and among these were the mayor, aldermen, council, commissioners and a few others. Doctors were required to pay five and apothecaries four guilders for admittance. The payment of four guilders by the apothecaries admitted them to the lessons given by the professor of botany four times a week during June, July and August.*

The present botanical garden of Amsterdam is commonly known as the Hortus Botanicus, and is connected with the Botanical Institute of the University. This garden has been made famous through the well-known work of Professor Hugo de Vries. Accordingly I desire to confine my statements almost entirely to a brief description of the Primrose Garden of Professor de Vries, part of which is shown by the accompanying photographs.

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*I have translated the above facts from a Dutch History of Amsterdam.

The Primrose Garden of Professor de Vries occupies about one-third of the entire botanical garden of the University of Amsterdam, and now contains only primroses with which he is continually experimenting. The primroses were first discovered by Professor de Vries in a state of mutability at Hilversum, Holland, in 1889. Some of these mutable forms were transferred by him to his garden in Amsterdam. Professor de Vries has repeatedly visited the original primrose field at Hilversum, in order to observe the forms still growing there. The remaining primroses in the original primrose field are disappearing owing to the fact that pine trees have been planted there, which are rapidly crowding out the plants. Quite a number of forms in various stages are still to be observed on the field at Hilversum, as I noticed when I visited this field on one occasion, in company with Professor de Vries. The primroses brought from Hilversum to Amsterdam have been increased greatly in number and new forms have been produced from the original individuals.

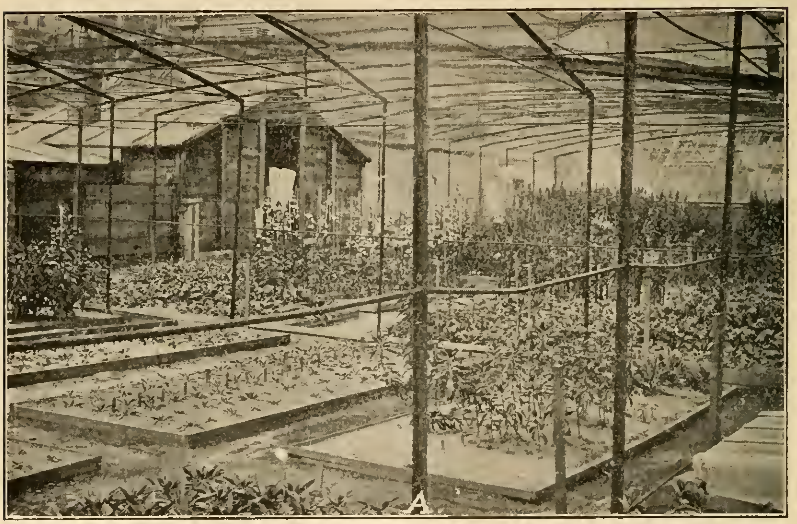

FIG. 1. Part of Primrose garden, in the Botanical Garden of the University of Amsterdam, where the experiments of Professor Hugo de Vries on mutation are conducted.

The primrose garden at Amsterdam is arranged in two parts. In one part the plants are grown inclosed in a house with a glass roof, quite as in an ordinary greenhouse. This garden house, which is about fifteen meters wide and thirty meters long, has board walls that are about three meters high. The gently sloping roof is supported by iron beams, and the whole building is strengthened by transverse iron rods at the top of the walls. Three sides of this house are closed continually, but one side may be opened or closed as desired. It is thus possible to grow plants in this part of the experimental garden under conditions, and at times, that would not be possible out of doors. By noticing the photograph it will be seen that the primroses are arranged in rectangular beds in which, when the young plants were first set out, they were arranged in absolute order.

2 Professor de Vries in the garden.

The entire roof and sides of the part of the garden, shown in Figure 1, is covered by a rather coarse-meshed wire net, supported, as shown in the photograph, by vertical iron posts about three meters in height. By noticing this photograph carefully the meshes of the net can easily be seen. The purpose of this sort of a net-like protection over the plants, is to keep out birds and other creatures that would interfere with the plants under experimentation. At the same time light and air are freely admitted. The part of the garden thus covered by wire netting is considerably larger than the part covered by glass, being about sixty by sixty meters. As already indicated the arrangement of the plants in beds is well shown in Figure 1. These beds are about two meters wide and four meters long. Great care is taken in the sterilization of the soil for these beds, and the planting of the young plants. The beds in the foreground show with what care and regularity the young plants are arranged. The designation of the various plants is shown by means of carefully labelled boards, which as here shown, are arranged in a line through the center of the beds. Even in spite of all the care and precaution that can be taken in preparing the soil and protecting the primroses, nevertheless some of the plants are often attacked and killed by a kind of worm just about the time the plants, after much time and work have been bestowed upon them, are about ready to show the results of the experiment. At the left, in Figure 1, are shown five primroses with paper bags tied over the flower part. These bags allow the passage of light, and protect the flowers from the visitations of insects during experimentation. The bags are carefully tied at the lower end about the flowers. Each year a great many primrose plants are planted and experimented upon. The keeping of the records of this vast number of plants, and the hundreds of pollinations performed each year by Professor de Vries, requires a vast amount of work, or "bookkeeping," as he once expressed it, to keep all the records clear and in a usuable form.

Figure 2, shows Professor de Vries in his primrose garden. The photograph was taken of the left-hand corner of the garden near the green house shown above.

PLANT ASSOCIATIONS OF THE DESERT LABORATORY DOMAIN AND ADJACENT VALLEY.

BY V. M. SPALDING.

(Continued from February Number.)

(4) SALT-SPOTS; ASSOCIATION OF SALT-BUSHES.

The description already given holds in all its general features for the soil and vegetation of the flood-plain of the Santa Cruz River, but certain areas, some of which approach the neighborhood of Tumamoc Hill, are so exceptional in character as to call for a special account.

The so-called salt-spots include areas varying from a few rods to many square miles in extent, and are widely distributed throughout the arid and semi-arid regions west of the Rocky Mountains. As they occur in the Santa Cruz Valley, and also in the valleys of the Gila and Salt Rivers in Arizona, they are areas of low ground, insufficiently drained, in which have accumulated alkali salts, especially salts of sodium, and which are conspicuously marked both by the presence of various species of Chenopodiaceæ ("salt-bushes"), and also by the absence of many species characteristic of surrounding areas.

In the lowest part of such spots, where the drainage is most defective, *Suæda Moquini* is characteristic, and in some cases is well-nigh exclusive in its occupation of the soil. Commonly, however, there are associated with it a few other plants, especially one or more species of *Atriplex.* Thus *Atriplex lentiformis* grows luxuriantly, even where the so-called black alkali, chiefly sodium carbonate, forms a heavy crust, and both *Atriplex Nuttallii* and *A. elegans* are of frequent occurrence in low spots where the accumulation of alkali has reached a high percentage.

Beyond this association and outside of it, *Atriplex canescens*, in many cases, is conspicuously present. Its range, however, extends over the flood-plain and even beyond it, so that although closely related genetically, it can not be referred to the more restricted association of salt-bushes which have the salt-spots as their habitat. Thus a zonal arrangement, often well marked, is produced, in which the center may be quite bare of plants, while around it, in successive concentric zones, are (1) *Suæda Moquini* and *Atriplex Nuttallii*, (2) *Atriplex polycarpa*, (3) *Atriplex canescens* and various other species which belong around or outside the limits of the salt-spot proper.

It has been shown by Cannon that at the salt-spot on the flood-plain of the Santa Cruz, just north of Tucson, where there are three well-marked zones of vegetation, alkali salts are most abundant in the inner, least abundant in the outer, and intermediate in amount in the intermediate zones.

In view of their persistency in such habitats, and in a definite order corresponding to amounts of alkali, it seems well-nigh self-evident that *Suæda* and several species of *Atriplex* must be regarded as true halophytes or "salt-loving" forms; that is, as having become especially adapted to soils containing a large percentage of alkali salts. It is true that in the vicinity of irrigating ditches the species characteristic of salt-spots, and especially *Suæda Moquini*, grow more luxuriantly than in the salt-spots themselves, but this is a physiological response characteristic of plant life in general, and can hardly be taken in evidence.

The question of soil preferences involves great difficulties, due in part to the apparently contradictory deportment of many plants that have been cited in evidence, and still more to lack of sufficiently extended observation and experiment. The interesting experiments of Kearney and Harter on the comparative tolerance of various plants for the salts common in alkali soils shows clearly the great complexity of the subject when the relation of any plant to a mixture of alkali salts is under investigation. On the other hand, an illuminating discussion of the soil preferences of alpine plants by Fernald has brought forward so many incontrovertible facts, established by years of careful observation, that it no longer seems possible to doubt that the chemical composition of underlying rocks has been an important factor in determining the distribution of the remarkable ecological group to which his study has been directed; the whole question, however, calls for experimental investigation.

(5) THE WASH; PALO VERDE-CATCLAW ASSOCIATION.

At the foot of Tumamoc Hill, on the northwest, there is a "wash," formed by the union of a number of similar ones which come down from the long slopes to the westward, the system presenting throughout its extent the usual features of a dry watercourse, with sandy bottom, along which a dense vegetation of shrubs or low trees marks its course even when seen at a distance. The wash with its branches constitutes a drainage system for the west slope of Tumamoc Hill on the one hand and the east slope of the nearby hills of the Tucson Range on the other, forming the natural channel or run-off into which water runs or seeps from the adjacent banks. Though its bed is usually dry, there are abundant indications of the presence of water below the surface, especially in the character and habits of its vegetation. In the first place certain species, notably the creosote bush, attain here a size and vigor of growth in striking contrast with the low, straggling individuals of the slopes nearby; and, secondly, other species, particularly the mesquite, everywhere taken as an indicator of water, are conspicuously present. Both of the species just named are prominent constituents of the vegetation of these washes, but since their characteristic habitats are elsewhere, other species have been chosen to give their name to this association, viz, the palo verde (*Cercidium Torreyanum*) and catclaw (*Acacia Greggii*).

At present, as the process of base-leveling slowly proceeds, these species are advancing from the flood-plain toward the adjacent hills. *Cercidium Torreyanum* is already found far up one of the gulches of Tumamoc Hill. The catclaw deports itself in the same way. *Ephedra trifurca*, another characteristic species, ranges still more widely, approaching the habits of the creosote bush in attaining its best development where there is an abundant water supply, but like the latter, capable of maintaining itself successfully where the water content of the soil is lower, especially on light, more or less sandy soils.

A few other woody species find in this habitat a congenial home. *Condalia spathulata* attains here its best development. *Condalia lycioides*, a companion of the mesquite, advances with it up the washes, and *Celtis pallida*, here a plant of the cliffs, also occurs in the wash, absolutely avoiding the intervening slopes, thus presenting further evidence, if such were needed, that soil-water is a factor of prime importance in determining the distribution of this association of plants.

Five of the species that have been named as members of this association have been observed by Blumer to change their topographic location with altitude. These are *Cercidium Torreyanum*, *Acacia Greggii*, *Prosopis velutina*, *Condalia lycioides*, and *Celtis pallida*. At Tucson, at an altitude of 2,200 to 3,000 feet, all of these inhabit the washes, and with a single exception (*Celtis pallida*) are hardly met with at all elsewhere; but at higher elevations, 3,500 to 4,500 feet, in the neighboring mountains of the Tucson Range, the Santa Catalinas, and the Rincons, they are found spreading out on gravelly and other upland soils, no longer confined to washes, and deporting themselves as ordinary members of the shrubby upland growth there prevalent. Taking these higher elevations as the point of departure, it is found that even 1,000 feet lower all these species exhibit a marked tendency to confine themselves to watercourses or, at all events, to places where there are good conditions as regards soil-moisture and some degree of protection from the more extreme desert conditions prevailing at the lower levels. The single individual of *Yucca elata*, a plant of higher levels, that has been found on the Laboratory domain, is at the edge of the wash, protected by the higher vegetation around it.

It should again be noted, as already suggested, that many of the characteristic species of the habitats thus far discussed, though exhibiting more or less plainly certain structural features distinctive of xerophytes, are semi-mesophytic or mesophytic, in some cases even hydrophytic, as regards soil relations. The willows and cottonwoods of the river-banks are, in their habits, what they are the world over. The mesquite of the flood-plain sends its roots down to the water-table, and elsewhere is restricted in its range to habitats in which a satisfactory water-supply is at hand, and the palo verde and catclaw of the washes evidently have much the same dependence on a sufficient amount of soil-water.

The same thing appears to be true of various species of salt-bushes, which follow watercourses, or—in the salt-spots—occupy places of seepage. In view of their habits, it may be fairly questioned whether such xerophytic structures as some of the salt-bushes exhibit stand primarily in relation to "physiologically xerophytic" soil conditions or not; in fact, it seems not at all improbable that they may be found to fall into the same category with the mesquite and catclaw, exhibiting certain xerophytic structures which are useful in the dry air of the desert, and which also in cases of extraordinary drought successfully regulate transpiration and make less draft on the resources of the plant.

(6) THE MESA-LIKE SLOPES.

(*a*) *Creosote-Bush Association.*

The long, gentle slope of the "mesa," as it is commonly but incorrectly called, rises from the flood-plain, at first with an almost imperceptible grade, becoming steeper as the ascent continues to the hill above. Its soil, as already stated, is mainly gravelly or sandy, with but little loam and with a considerable amount of caliche. The slope and the nature of the soil insure perfect drainage and aeration. But with the poor soil, with relatively little capacity for the retention of water, it is plain that we have passed, almost at a step, from soil conditions that may be classed as mesophytic, or semi-mesophytic, to those that are suited only to distinctively xerophytic plants, such as grow where peculiarly trying conditions prevail. Under these conditions as might have been anticipated, nearly all of the perennial species of the flood-plain abruptly cease; in fact, the creosote bush is the single one that is capable of successfully holding the ground on the worst places, and even this is dwarfed in the struggle to maintain existence where the water supply is never abundant for any length of time, and through a large part of the year is necessarily meager in the extreme. Yet, in spite of these untoward conditions, the *Larrea* claims this zone as its own, and has produced upon it an almost pure growth of a single species.

It is impossible, as yet to enumerate completely the peculiarities of this plant, structural and physiological, which have enabled it, more successfully than any other, to cope with the worst of desert conditions as they exist in the Southwest. Some of these, however, are obvious. It is provided with a root-system which both penetrates deeply and also branches widely near the surface, thus being in a position to avail itself of water that accumulates at either level; it is capable, as few other species are, of absorbing appreciable quantities of water through its leaves, and these are admirably protected by varnish and in other ways against excessive transpiration. With the coming on of drought a large percentage of its leaves are thrown off and a still further reduction of surface is accomplished by the leaves becoming checked in their development long before they have attained their full size, as seen in individuals of the slopes compared with those of the flood-plain and washes. Its mode of branching and reproduction from the root is also advantageous. Whole systems of branches die, and thus permit their share of water from the soil to go to others, and, if under extraordinary stress, the whole top perishes, fresh shoots from the root come up upon the return of rain, and vigorous growth again takes place. Fitted in so many ways, and probably in others less obvious, to cope with the vicissitudes of its habitat,the *Larrea* holds complete sway in this zone, and from Texas to California the broad belt of creosote bush, covering the long slopes that form the approach to the mountains at different altitudes, presents a most striking and characteristic feature of the landscape.

A few other species are of occasional occurrence in this special habitat of *Larrea*. Thus on the slope at the foot of Tumamoc Hill a very few individuals of *Fouquieria splendens* are established, and in places *Opuntia fulgida* is frequent; none of these, however, approach the creosote-bush as the universal and distinctively characteristic species of this zone.

As the slope advances upward with the long continuance of disintegration and erosion, the creosote-bush advances with it, and the presence of this plant, both as the successful pioneer and the final possessor of the soil, may be seen almost everywhere throughout its range. Thus we have the interesting case of a well-marked habitat, with a single species forming in it, at least in places, a perpetually renewed close association of its own.

The description just given applies to the slope as seen near the foot of Tumamoc Hill and in situations such as the "alluvial fans," where the conditions of slope and soil characters are essentially similar. There are wide areas commonly included under the term "mesa" upon which a greater variety of conditions, with corresponding differences of vegetation, prevails. An example of this is the ground included in the Laboratory domain lying to the west of the wash presently to be described.

(*b*) *Franseria Association.*

Beyond the wash, on the Tucson slope west of the Laboratory and elsewhere on the domain, areas of considerable extent occur where there is a soil of coarse texture, approaching gravel, on which *Franseria deltoidea* and *Opuntia fulgida* constitute the greater part of the vegetation. The former is often very numerously represented, and in many places is not accompanied by the cholla, but where the two attain their best development they are likely to occur together. Frequently *Krameria canescens* and a few other species are associated with them. As far as appears from present evidence, this association is one that is determined first of all by soil relations. These are described in a later paragraph.

(7) THE HILL.

Above the *Larrea* zone the hill is the habitat of a large number of conspicuous and characteristic perennials, which, although they may be classed together as a single association, differ among themselves to such an extent in ecological traits and choice of habitat as to call for consideration under separate groups.

(*a*) *Plants of general occurrence on all exposures; association of Fouquicria and Parkinsonia microphylla.*

The species of this group, more than any others, give its character to the vegetation of the hill as a whole. Growing as they do, equally well on all exposures, to differences of which members of other groups show remarkable sensitiveness, they form at once the most widely-spread and most typical representatives of the vegetation of Tumamoc Hill. Their adjustment to a wide range of physical conditions seems well nigh perfect, yet it is exhibited in many different ways. The habits of the *Fouquicria* and *Parkinsonia*, to go no further, are very different as regards the production and fall of foliage leaves, arrangements for protection, and other ecological characters, but they grow side by side on all exposures and on various soils, so that, however limited some of them are as to geographical range, it is plain that within its limits they have attained a high degree of adaptation to widely varying soil and atmospheric conditions, and are to be reckoned as highly successful desert species.

(*b*) *Plants occurring on southern exposures and largely wanting on northern ones; association of sahuaro and Encelia farinosa.*

The species just named are closely and widely associated and are both far more numerous on southern exposures, as well as eastern and western, than on northern ones. This is strikingly shown on the two sides of the gulch adjacent to the Desert Laboratory on the southwest. On the right side of this gulch, with a southern and partly western aspect, there are upwards of 70 sahuaros and the ground is almost covered with a flourishing growth of *Encelia*, numbering thousands of individuals. The left bank, on the other hand, with its generally northern aspect, has less than a dozen sahuaros and only a few scattering groups of *Encelia*. Observations of temperature and humidity and experiments with seedlings have been in progress for some time, with a view to determining as far as possible the factors to which this striking limitation as regards local habitat is due.

(*c*) *Plants occurring on northern exposures, but wanting on southern ones; Lippia association.*

On the left side of the gulch just referred to, and near its head, *Lippia Wrightii* forms an extensive patch, and in the vicinity of Tucson it frequently occurs on similar northern exposures, never, as far as observed by the writer, on a southern exposure, but in the Chiricahua Mountains and elsewhere, as shown by Blumer, it exhibits a marked variability in choice of ascent as governed by altitude; thus at elevations of 3,000 feet and under, it grows only in protected places of north aspect, but loses its aspect preference at altitudes approaching 5,000 feet, while at those near 6,000 feet it is definitely limited to southern exposures.

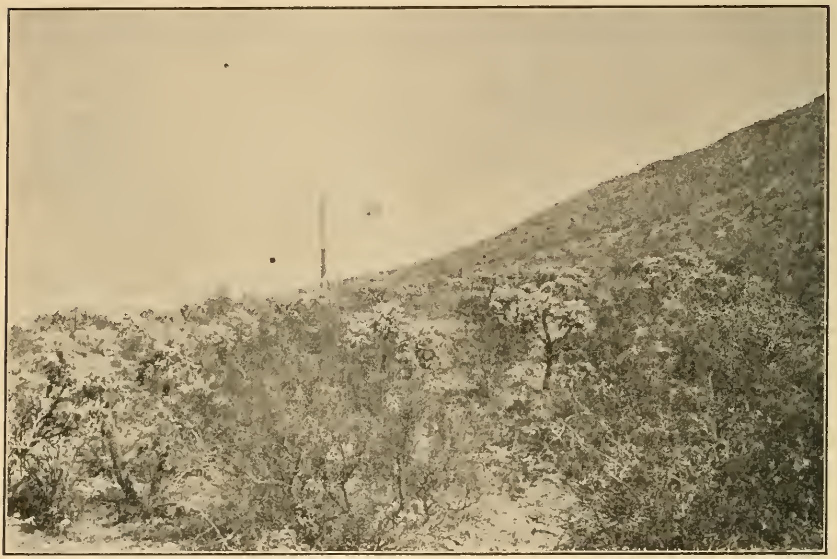

FIG. 3. West slope of Tumamoc Hill. Thick cholla in the foreground.

It appears, then, that this plant completely changes its aspect preference within a range of not more than 3,000 feet. At the lower levels it requires protection from too severe desert conditions, and finds this on sheltered rocks of northern aspect. At the higher altitudes apparently requiring protection from cold, it finds a congenial home on warm southern exposures, while at intermediate elevations, in the neighborhood of 5,000 feet, the extreme conditions of both higher and lower altitudes are so far modified that it grows on all exposures.

Various other species show at this place a distinct preference for northern exposures of the hill. Among these are *Abutilon incanum*, *Brodiaea capitata*, and many others, annuals even more conspicuously than perennials. It is evident, however, from the facts cited in the case of *Lippia*, that this choice of aspect is not necessarily constant, and that direction of slope determines distribution merely as it presents a combination of conditions which may change so greatly, even within a few miles as to completely reverse the aspect preference of a given species.

(*d*) *Plants of the cliffs; Hyptis-Nicotiana association.*

One species of each of the genera just named is found growing almost exclusively on the abrupt cliffs of Tumamoc Hill and on similar cliffs elsewhere. *Celtis pallida*, though by no means confined to the cliffs, is of common occurrence on them, where it evidently finds a congenial home. The factors concerned in determining the choice of habitat exhibited by members of this association are not known. It may well be that where there is so little soil the result may in part be the outcome of competition, but regarding this point we are without positive knowledge. *Hyptis* and *Nicotiana* are rarely seen growing elsewhere, though the latter is sometimes found growing in the sandy soil of washes, and in this latter habitat *Celtis* is of rather frequent occurrence. I am disposed to think of water supply as again the main factor.

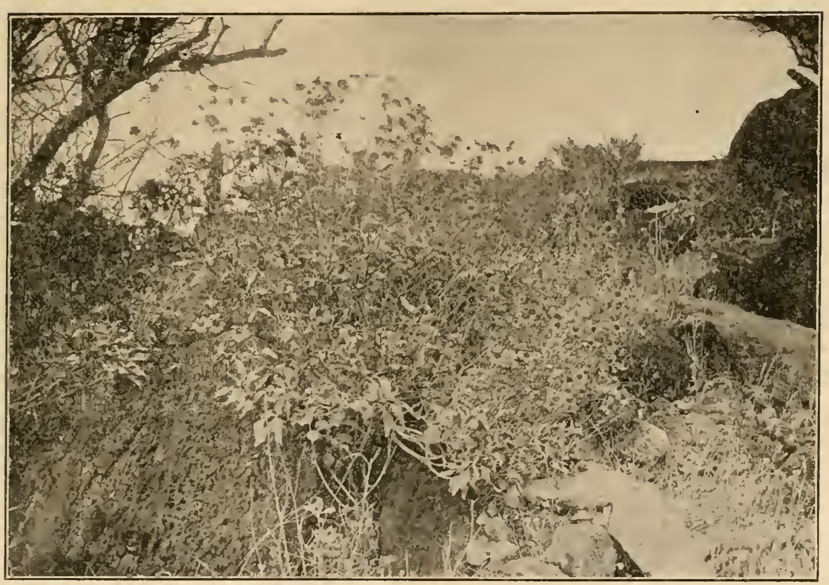

FIG. 4. Deltais of vegetation near Desert Laboratory. *Encelia farinosa* in flower.

There are probably pockets or fissures in the rocks where *Hyptis* and other plants obtain what they need, and the occurrence of *Celtis* and *Nicotiana* in washes looks to this also.

(*Continued to April Number.*)

MUTATION IN THE ŒNOTHERAS. *

By S. B. Parish.

The present is the fourth fascicle of the Abbe Léveillé's monograph, the publication of which was begun in 1902, and brings it near completion. A final part, soon to appear, will contain a general key, Latin diagnoses of the species, and other supplementary matter.

The author takes a most comprehensive view of the genus Œnothera, not only rejecting the segregation proposed by Raimann in the Pflanzenfamilien, but including Gayophytum, Godetia, Eulobus and Boisduvalia; a disposition not likely to be followed by the most conservative of field botanists. The numerous text figures are mostly very good, especially some of those of seeds. The photographs of herbarium sheets are of more uneven merit. Maps of distribution are given for many species, reproduced from those published in 1898, by Professor A. S. Hitchcock. The value of the work is enhanced by the very full citation of collections, and greatly diminished by the entire absence of citations of place in the extensive synonymy.

The present part devotes some interesting pages to an account of the author's experimental cultures of De Vries' mutants, continued for five years in M. Léveillé's own garden and at the Jardin des Plantes at Le Mans. The species cultivated were *Œnothera Lamarckiana* "a l'etat du mutation," Œ. *gigas*, *Œ. rubrinervis*, *Œ. nanella* and *Œ. cruciata*, all grown from seeds furnished by De Vries from his own cultures.

Our space does not permit a detailed account of these experiments, and we must content ourselves with a condensation of some of the most important.

The first year there appeared from the seed of *Œ. Lamarckiana* a few specimens which differed from the parent, but which seemed to Léveillé mere sports or forms, and the same was the case with *Œ. nanella*. *Œ. cruciata* was so distinct that he was disposed to consider it a good species. In the second year all the forms cultivated in the Abbe's own garden reverted to *Œ. rubrinervis*, while those at the Jardin des Plantes, grown from the seeds of the *Œ.Lamarckiana* and *Œ. rubrinervis* of the preceding year, were more or less nearly identical. Two forms of *Œ. rubrinervis*, which had appeared the first year, continued constant, but differed merely in foliage. Plants from last year's *Œ. gigas* showed reversion either to *Œ. Lamarckiana* or *Œ. rubrinervis*. Only *Œ. cruciata* remained distinct.

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*Monographie du genre Œnothera, par Monseigneur H. Léveillé. Le Mans, 1909.

The third year all the young plants, from the different forms, reverted to *Œ. rubrinervis*. The most interesting development of the present year concerned the original plants, which proved distinctly perennial and flowered freely, but exhibited decreasingly well marked differences, and a greater or less tendency toward *Œ. rubrinervis*. *Œ. cruciata* still retained its markedly distinctive character.

The next year, *Œ. cruciata*, hitherto so constant, and now four years old, produced from the same stem the large flowers of *Œ. parviflora* and its own small cruciate blossoms. A good figure shows these very different flowers borne each on an opposite branch of the same stem. For the rest there remained the robust *Œ. rubrinervis*, reverting to the original stock (stirp), and bearing the flowers of *Œ. biennis*.

Among the conclusions drawn by the author from his experiments are some not without interest to the student of mutation. He defines mutation as consisting in an inherent tendency in the seeds of plants which causes them suddenly to produce a number of individuals more or less different from the parent. That these aberrant characters should persist and develop it is necessary that their environment should be notably unlike that in which the seed was produced, otherwise a reversion to the parent stock will occur in the third or fourth year.

The leaves, the degree of hairiness, the size of the flowers, all vary so greatly in Œnothera as to be without value in the delimitation of species. Since vegetative organs vary in accordance with the environment, it would seem that the specific entity which manifests itself in the whole character of the plant should be sought in an anatomical or morphological study of the seed.

He defines autometamorphism as the possession by a seed, in itself, of the essential nature (l'instinct) of the family or genus to which it belongs. While mutation accounts for the origin of varieties and forms, autometamorphism enables us to determine the properties of species and to recognize their affinities and true stocks. Autometamorphism may be said to be a centripetal force, and mutation a centrifugal.

The author holds that there are certain primordial species, the only ones existing in nature, represented by a few types; the difficult thing being to disentangle these from the innumerable products of mutation and hybridization, which authors wrongly raise to the rank of species.

"M. Hugo De Vries," concludes the Abbe, "has codified horticultural practices and clothed them in scientific formulas, something which no one before him had ever dreamed of doing; he explains the origin and establishment of races; that of species remains a problem."

THE EFFECT OF MOISTURE ON THE GROWTH OF USNEAS.

By R. HEBER HOWE, JR.

Mr. A. W. C. T. Herre, in the PLANT WORLD (12:257. 1909), criticizes my statement that the "great luxuriance of Pacific coast specimens, (is) due evidently to abundant moisture." (Bull. Torr. Bot. Club 36:315. 1909). He writes: "This is not so evident to those of us who live at present on the Pacific Coast and who are familiar with the flora of all parts of the United States; it may be true of some species perhaps, but it certainly is not true of the *Usneas* of which he is speaking. One could hardly be so sure of abundant moisture when six or seven months often pass without rain, the annual precipitation of 15 to 40 inches coming during the winter months. It is true that there are some summer fogs, but they lack much of supplying adequate moisture, though of course they have an appreciable effect upon vegetation. The aridity of California in general is shown by her xerophytic forests and impenetrable gnarled chaparral, and by the great number of endemic xerophytic lichens, such as *Heppias* and *Acarosporas*.

"The excessive length of species of *Usnea* in some regions is directly due to having never been disturbed; for example, *Usnea longissima* reaches a length of six or seven meters in the forests of Baron Rothschild's estate in Hungary, where an axe has not been allowed for more than one hundred and fifty years; here in California it is ten or twelve feet long only in the redwood forest not yet visited by the lumberman, where it grows upon trees which are 500 to 1,500 years old. The author also believes that the greater size of many California lichens may be due to the prolonged growing season (of seasonal and continuous rains), though of course this can only be settled by careful measurements and extended series of observations."

I do not desire to enter into any controversy with Mr. Herre, nor to question that his knowledge of the climatic conditions of the Pacific Coast is greater than mine, for I have never been west of Wyoming; but I do wish to state the facts gathered from reliable sources, and from Mr. Herre's *own* works on which I partially based my statement, and the import of which he has evidently forgotten.

In the first place the "Pacific coast", as I used the term, extends from the coast of Southern California to Alaska; the rainfall figures which he gives, "15 to 40 inches" per annum, referred, I take it, to his own state of California, *inland* as well as *coast* stations figuring in the average. The annual average rainfall of the Pacific coast is about 65 to 70 inches, and climatic "moisture" including humidity (84%), ocean fogs (.14 inches per day for 250 days—35 inches rainfall approximately), and rainfall (21.71 mean, 34 max., 12.44 monthly max. Dec.) for the region of Alpine Creek Canyon, San Mateo Co., Cal., where the local effect on *Usnea plicata* (L.) Web. (*Us. Californica* Herre?) * was one of the instances I had in mind. In the latter place it averages yearly the equivalent in other words of approximately 55 to 60 inches rainfall. †

In Mr. Herre's paper (Bot. Gaz. 38:218-219. 1904) on the growth of the closely allied *Ramalina recticulata* Kremp., made, I take it, near Stanford University or in the Santa Cruz mountains (San Mateo Co.), the only localities cited, he writes:

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* *Us. barbata* var. *ceratina* Schaer. of Tuckerman, a contingent phase of *plicata*.

† McAdie, Climatology of Cal. 1903.

"Tuckerman states that his longest specimens were a little more than a foot in length, and that the widest perforated expansions exceeded 20 mm. Just what dimensions this plant may attain I am not prepared to state, but I agree with Dr. Peirce that it is probably the largest of our North American lichens. Specimens, four or five feet long are common on the trees about Stanford University, their widest perforated expansions reaching two feet or more. Specimens in my herbarium vary from those of the most delicate lace-like structure to those having broad, unperforated expansions 25 to 40 mm. in width, dimensions much greater than the largest perforated specimens seen by Tuckerman. *Usnea longissima* Ach. attains a length of eight or nine feet on the redwoods of the Santa Cruz Mountains, but the thallus is so slender that its real size is much less than that of *Ramalina recticulata.*

The plant is evidently such a rapid grower that last September a series of measurements were made, at the suggestion of Dr. G. J. Peirce, in order to obtain some definite results....... The winter rains did not begin for nearly two months after the measurements were made, and ceased two or three weeks before the lichens were re-measured, so that most of the growth was confined to a period of about five months. During the late winter and early spring growth must have been both rapid and continuous, since for nearly two months it rained almost daily, the temperature also being favorable for growth." Mr. Herre also records similar results obtained for "*Parmelia caperata* (L.) Ach." of his paper, corrected in ink in my copy by Mr. Herre to "*Parmelia soredica* Nyl."

That undisturbed growth, and a prolonged growing season are undoubtedly important factors in luxuriance of growth is most probable, but that "moisture" (=rainfall, fog, and humidity) also is one of the main factors is not based on a mere guess, nor on the general opinion of lichenologists, but on a year's study by the author of growing plants, the conclusive results of which investigation will be found in this magazine (11:54. 1908. Pl. 6) The statement is reprinted here. "During the past year I have measured the growth monthly of two examples of this species (*Parmelia caperata*), with the following results, though no doubt substratum, the character of its surface, the exposure, and the climate have much to do with the rapidity of growth.

Here in Concord, Massachusetts, on a vegetable substratum of average roughness (*Pyrus*-apple and pear), and in a climate of periodic rainfall, amounting to about 40 inches per annum, (maximum, August, 4.12 in.) and with a humidity of 82% (maximum, autumn), two examples, one with a southern and one with a northern exposure, showed that the greatest growth was accomplished during the months of heaviest rainfall, and not only by the plant with the northern exposure, but on the eastern periphery of this plant. We might learn then, that moisture, and cool shade are most favorable to such foliaceous lichens." Since this paper was written I have completed a two year's study of *Usnea florida* (L.) Web. with the same results.

I have examined, during the past few years, nearly five hundred *Usnea* specimens from the Pacific coast, and several hundred from California, and I have yet to see a luxuriant specimen of this genus from the "xerophytic forests" and chaparral regions of the interior of California, an area to which I never alluded. As to the wonderful growth of *Usneas* on the great redwoods, where Mr. Herre says "here in California it (*Us. longissima*) is ten or twelve feet long only in the redwood forests" (l. c. 258), a California authority writes these *Sequoia* forests occupy the "Coast ranges, where they are exposed to ocean fogs, from the northern limit of the state to the southern borders of Monterey county, but are most abundant north of San Francisco." Mr. Herre also speaks, himself, of the "fog channels and rain-laden wind currents of the Coast Range mountains" (l. c. 257).

I am free to admit that there are many causes for unusual local growth of lichens that are still, and probably will be, a sealed book to me, and that it might have been better to have worded my sentence: seemed due in fact to abundant moisture. The plate in Bull. Torr. Bot.Club, 37: Pl. 3 Fig. 4, 1910) will show the "robust" * luxuriance to which I referred, a condition that I cannot think any undisturbed *Usnea* growing in the past primeval forests of the eastern states ever exhibited, even before the arrival of the white lumberman.

As I have already remarked elsewhere, western coast *Usneas* show a paler and more stramineous coloring as compared

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*Diagnostic word used in Mr. Herre's original description of *Us. Californica*. The word "bulkiest" was also used. (Proc. Wash. Acad. Sci. 7:34-5. 1906).

with the eastern more virescent examples, this being due, as cross sections of the thallus prove, to a thicker cortex, obscuring the consequently deeper buried algal layer.

The reason for the luxuriance (not of length alone) of Bavarian highland *Usneas*, particularly *Usnea longissima*, is also, I think,to be explained by the large rainfall of the region,*i.e.* 60 inches per annum, and not a little no doubt to the frequence of cloudy, damp days. The luxuriance of *Usneas* in equatorial regions of South America and Africa is in accordance with the larger rainfall, and this is particularly well shown in a comparison of plants from the eastern (wet) and western (dry) slopes of the Andes in Bolivia.

The *Usneas* reach as I have already said, their greatest development in North America on the Coast ranges of the Pacific coast, from Monterey county, California, to British Columbia, especially on this coast between San Francisco and Chehalis county, Washington, which area lies in the greatest rainfall belt on the continent, and Mr. Herre in his prefatory remarks on "The Foliaceous and Fruticose Lichens of the Santa Cruz Peninsula" writes "The Pacific side of the peninsula is very moist and in the fog-laden air of the redwood or forest formation certain forms of lichens reach a development perhaps unsurpassed elsewhere." Have I said more than this?

BOOKS AND CURRENT LITERATURE.

An Ecological Survey of Isle Royale, Lake Superior, under the direction of Charles C. Adams, has recently been published by the State Biological Survey of Michigan. It is a work of 468 pages, illustrated by numerous photographs and maps, and provided with a very comprehensive index.

Part I, on Isle Royale as a Biotic Environment, and Part V, on the Ecological Succession of Birds, were prepared by Dr. Adams; Part II, on the Ecological Relations of the Invertebrate Fauna of Isle Royale, is by Dr. H. A. Gleason; Part III, on the Ecological Distribution of Birds of Isle Royale, is contributed by Otto McCreary; while Part IV, on the Fall Migration of Birds at Washington Harbor, Isle Royale, is by Max Minor Peet. Acknowledgment is made of financial aid from Mr. Bryant Walker, of Detroit, and Hon. Peter White and Mr. H. M. Kaufman, of Marquette, as well as of the cooperation of a large number of specialists who determined species and otherwise aided in the work.

The aim of the work, as set forth in the words of the Director, was not simply to collect specimens, but also to study the relations of the plant and animal life (the biota) to their surroundings. The environment as well as the biota was considered from a dynamic standpoint, and an effort was made to analyze the environment in order that the dominant conditions and processes of which it is composed might be recognized, and their laws of change be perceived and formulated. . . . . In preliminary work of this character, it is considered of special importance to discover, if possible, the order of the major biotic successions, because these successions must be clearly perceived before their causes can undergo adequate analysis. Our knowledge of causes generally lags far behind our recognition of succession. Thus throughout the study of the Isle Royale biota a special effort was made to investigate the genesis or succession of events. . . . . But the problem of succession is only one of several which clearly show the intimate relations and responses between organisms and their environment; others that remain to be investigated involve physiological and structural changes, and various modifications of habit and behavior of both plants and animals.

This and more which it would be desirable to reproduce, did space permit, serves to indicate the philosophical spirit and definiteness of purpose with which the work was conceived and carried out. It is interesting to note in passing that the writer was specially impressed with the *relative simplicity* of the problem of environmental relations and of the biotic succession upon Isle Royale, and thus has received further confirmation of the opinion that a tendency to exaggerate the complexity of the environment is prevalent.

An adequate analysis of the contributions of the several authors is obviously out of the question here. As the survey was conducted chiefly by zoologists, it would necessarily result that the plant life of the island could not, in the time available, receive sufficient study. This lack is in part made up by a supplementary paper on the Vegetation of Isle Royale, by W. P. Holt, who discusses the principal plant societies, and adds some notes of ecological value. The value of the report as a whole, however, would have been greatly increased had the plants of the Island received a proportional share of attention with the animals.

The Weeds, Poison Plants, and Naturalized Aliens of Victoria, by Alfred J. Ewart (Melbourne, 1909) is a useful book of upwards of a hundred pages illustrated with many colored plates, and written in simple style with a view to aid the farmers in preventing the spread of noxious weeds and poisonous plants. Australia has suffered great losses due to carelessness in this direction. The author states that there can be no doubt that if suitable regulations had been in force fifty years ago that country would now be saved an annual loss of several hundred thousand pounds, and though the government with its Thistle Pamphlet and list of "proclaimed plants" has accomplished something in restricting the evil, there is still a dangerous increase of some of the worst weeds of civilization. The work of Professor

Ewart will be indispensable in further efforts to combat the introduction and spread of the pests which it enumerates.

The Pteridophytes of Ohio, by John H. Schaffner, bearing date of January, 1910, has been published in the proceedings of the Ohio State Academy of Sciences. The census of the species includes:

Ferns, 44 species.
Equiseta, 8 species.
Lycopods, 6 species.
Water Ferns, 1 species.
Selaginellas, 2 species.

The glossary and index add to the value of this carefully prepared and convenient little manual.

NOTES AND COMMENT.

We print elsewhere in this issue Mr. Parish's admirable review of Léveillé's extensive work on the evening primroses. The earlier parts of this publication appeared at a time when interest in the group was keen by reason of their extensive use in De Vries' cultures. The arbitrary treatment, and disregard of much information derived from a field study of these plants displayed, however, caused American botanists to lose interest in this work, and even the account of the cultural work carried out will hardly be able to revive it. It is to be noted that the *Œnothera cruciata* of the European gardens is not the species with regular narrowly linear petals known to Americans, but a hybrid, derived from a pollination of that species with *Œ. Lamarckiana*, as was pointed out by Dr. MacDougal in 1907 (See Pub. Carnegie Inst. of Wash., No. 81, p. 58). It may be regarded as a fixed hybrid, but in Léveillé's cultures was seen to give rise to a bud sport of one of its ancestors, a phenomenon well known in breeding work.

Few botanists actively engaged in productive work find leisure to present to the general public readable accounts of what they are doing, and sometimes attempts in this direction are not crowned with perfect success. When it does happen that one who is primarily an investigator and teacher is gifted in this way it seems proper to make a note of it, even if he is still alive.

One of our leading physiologists contributed to the *Popular Science Monthly* within the past year a paper on "Formative Influences," the perusal of which has brought joy to the reviewer and the conviction that not only is classical purity of style not a lost art,but also that the botanical fraternity still includes some who possess it. Witness the closing paragraph:

"The life-experiences of all living things, and even the things themselves, are the joint product of substance and circumstance. Some, if not all, of the substance is continuous, transmitted, from parent to offspring; some, but not all, of the circumstance attending this from the beginning to the end of its existence, is continuous. In the continuity of substance and circumstance lies the basis of the likeness of succeeding generations; in the difference of circumstance from time to time lies the basis of the difference which we see between offspring and parents. For circumstance is but Emerson's synonym for the evolutionist's word environment; and environment, on analysis, proves to be the sum of the formative influences."

The last word on evolution from Prof. T. H. Morgan is always worth pondering even if it is in some degree discouraging. In his presidential address before the American Society of Naturalists in Convocation Week at Boston we find these words which make one wish that other writers on this subject had been equally explicit as to their conception of evolution and the means of its demonstration:

"The position of the naturalist in regard to the causes of evolution is far from satisfactory and most unsatisfactory concerning the *origin* and *evolution* of *adaptation*. . . . . Our problem concerns the adaptations of species,and from this time forward when I speak of the origin of species I mean the origin of the adaptive characters of species. . . . . .The time is past when it will be any longer possible to speculate light-heartedly about the possibilities of evolution, for an army of capable and acute investigators is carefully weighing by experimental tests the evidence on which all theories of evolution and adaptation must rest. To them belongs the future."

The last list of publications in the Field of Botanical Science issued by the Carnegie Institution of Washington includes 19 numbers (20 separate papers) bearing dates from 1903 to 1909. These represent a relatively small part of the publications of the botanical specialists of the Institution within the period indicated. One reason, doubtless, is the expense that under the present system must be incurred by authors who distribute more than ten copies of their papers. These are sent out at actual cost of publication, but even at this investigators of limited means have found it necessary to publish much of their work elsewhere.

A study on the heredity and life-history of the trichomes in species and hybrids of Juglans, Oenothera, Papaver and Solanum, by W. A. Cannon, has lately been put out by the Carnegie Institution of Washington. The research was largely confined to examination of glandular hairs, and among the conclusions are the following. The trichomes vary in size within certain and limited bounds, and in a manner directly associated with the position occupied on the leaf, and not with the differences in vigor of the plants, at least in certain Juglans hybrids, although, so far as observed, the trichomes on young organs may be larger than on organs which are old. The distribution and reversion of trichomes indicate that hairs should not be grouped together as a "unit" character, but that each type of hair should be separately studied and considered a distinct "character."

The leading interest in the study lies in tracing the ontogeny of the glandular trichomes in the Juglans hybrids and pure species. The multicellular trichomes were found to have a form of development which is rigorously adhered to, at least in the smaller hairs, and similar hairs, not identical, were observed to have analogous sequence in cell-division by which they are organized. Where the development of different hairs takes a parallel course, kinship, based on the probability of common ancestors, however remote, is assumed. A deviation from the usual sequence of cell-division was observed in one type of hair by which an aberrant trichome resulted. This sudden departure is held to be an actual mutation, so that the trichomes in Juglans appear to take their origin in at least two ways, namely, by slight alterations in the number of cells, as more or less than the customary number, although there might be also a quantitative change, or by a new sequence of cell-division, which would result in a qualitative change. Thus the origin of structures in plants is found by histological studies to agree with the method of their origin as postulated by the experimenters in this field.

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A RAIN-CORRECTING ATMOMETER FOR ECOLOGICAL INSTRUMENTATION.

BY BURTON EDWARD LIVINGSTON.

Up to the present time there has appeared to be an insurmountable difficulty in the operation of the porous cup atmometer,* in the fact that rain falling upon the exposed cup penetrates, to some extent, into the reservoir below, thus introducing an unknown and practically indeterminate factor of negative evaporation. Screening the cups in any way so as to shield them from falling rain always alters the exposure to air currents or sunlight, or both, and thus diminishes the value of the instrument as a measure of the atmospheric environment of plants. It is possible to determine empirically the rate at which water will enter the cup when the latter is completely covered by a water film. This rate depends upon the porosity and superficial area of the cup and upon the length of the water column below. It occurs, however, that during the average rainstorm the entire surface is not by any means continuously wet. Gusts of wind blow the rain drops against one or the other side of the vertical cylinder, with a constant breeze one side is usually dry and may even sometimes be actually losing water, and only when the rain falls vertically is the cup uniformly covered with a water film. Also, slight showers often fail to furnish water at a sufficiently rapid rate to keep the porcelain surface wet. Therefore it is wide of the mark to assume complete wetting and to determine the rate of penetration and the duration of precipitation periods, calculating the absorption of water by means of such data.

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*Publication 50, Carnegie Institution 1906; Science, N. S., 28: 319. 1908.

After attempts in various directions, an arrangement has been devised which obviates the whole difficulty by preventing the entrance of water from the cup into the reservoir, while movement in the opposite direction may proceed as usual. The apparatus is extremely simple and adds but little to the trouble of operating the instrument. A diagram of the arrangement of parts is shown in Fig. 1. From the porous clay cup two glass tubes (A and B) extend downward, one of them reaching from the tip of the cup, the other only from the upper surface of the rubber stopper. These are slightly offset laterally so as to allow the other apparatus to be easily attached. They are of small bore, about 2 or 3 mm., as are also the tubes mentioned below. Each of these tubes passes through a 2-perforate rubber stopper into a shell vial (C, D) about 2.5 cm. in diameter and two or three times as high. Tube B reaches the bottom of the vial, tube A merely penetrates through the stopper. Through the remaining perforation in each stopper extends a second tube (E, F) bent first laterally about 5 cm. and then downward. Tube E reaches the bottom of the vial and the bottom of the reservoir G, while tube F reaches only through the vial stopper and extends about 10 cm. below the bend at its free end. Tube E is supplied with a loosely fitting cork stopper, which can be slipped upward or downward upon the tube. The reservoir G is treated in the same manner as heretofore, a file mark on its narrow neck serving as a nul-point in filling. In place of the bottle a graduated cylinder or a burette may be used, but it is desirable that the reservoir be

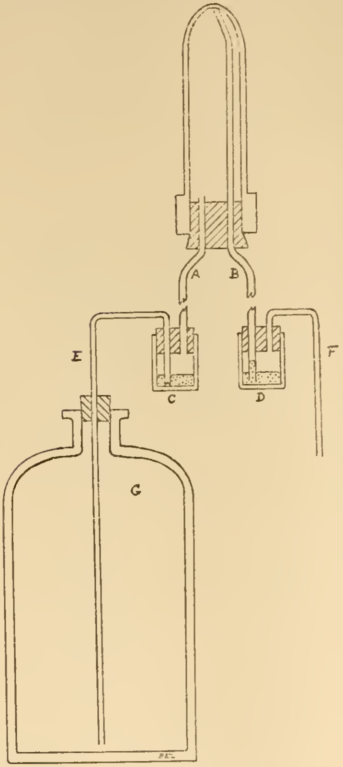

Fig. 1 Rain-correcting atmometer.

broad, so as to reduce the rate of change in the height of the water column as water is withdrawn.

The instrument is installed as follows: Vials C and D are supplied with clean mercury to a depth of 6 or 8 mil imeters and their stoppers tightly inserted. The stopper of the reservoir G is raised, the bottle slipped to one side, and filled with distilled water. A rubber tube is attached to the free end of the tube F and suction is applied, causing water to rise from the reservoir, filling first vial C, then the porous cup, then vial D, and lastly escaping into the rubber tube, which is then removed. After slight adjustments of the mercury level, by raising or lowering one or both vials, the instrument is ready for operation. A suitable support and a waterproof apron to protect all the reservoir from rain may be readily arranged. To replace the cup with a new one, the old cup is simply removed from its stopper, allowing the contained water to escape, the new cup is placed in position, and suction is applied to tube F as in installing.

As water evaporates from the cup, mercury rises in tube B and falls in tube E, until water from the reservoir passes freely from E to C. The lost water is now supplied as usual from the reservoir, the column of mercury in the lower end of tube B remaining at a height of a few millimeters. This height can be varied by raising or lowering the vials. Water cannot enter the cup from vial D and this vial remains filled. In time of rain, evaporation from the cup ceases, it absorbs water from without, the mercury rises in tube E and falls in tube B until water flows freely from the cup through vial D to the exterior. No water can enter the reservoir G from this direction, and the readings obtained from it will give the actual evaporation. Rain-water, (and dew also, if it plays a role here) is automatically shunted to the outside.

Various modifications of the instrument are of course possible, but the form here described seems most convenient when ease of filling and changing the cups is considered.

The error introduced by the volume change required for the operation of the automatic mercury valves is so slight as to be completely negligible in all climatic and habitat studies, and this form of instrument is not apt to be used for finer studies, such as those on transpiration.

An electric valve and automatic recorder may be introduced between vial C and the reservoir, or tube E may be partly of rubber and the reservoir may stand on a recording balance in a suitable shelter, thus rendering the instrument self-recording. Without the automatic removal of absorbed rain water the recording apparatus is always thrown out of function by any but slight showers. The present instrument will register or record evaporation as long as absorption by the cup does not equal or exceed its water loss. Thus, during a slight shower in an arid region, evaporation may continue to some extent throughout the precipitation period, especially if wind prevents the surface of the cup being uniformly covered with a water film.

The Johns Hopkins University,
Feb. 26, 1910.

AN ABERRANT WALNUT.

By IRA D. CARDIFF.

In the fall of 1903, a peculiar nut was sent from northern Indiana to Professor C. R. Barnes of the University of Chicago. The nut was borne on a tree which is walnut (*Juglans nigra*) in most, if not all, of its other characters so far as has been ascertained. This was said to be one of a number of such nuts which had been borne on this tree. The nut itself, externally at least, is very different in appearance from a walnut. It is divided transversely into two almost equal halves. The basal half, or that portion which is attached to the stem, resembles a walnut having a glabrous, roughly dotted, somewhat spongy hull. Upon drying it becomes regularly wrinkled and roughened with small pits and elevations. The opposite half, on the other hand, possesses a smooth exocarp of firm texture, without dots, and remains smooth upon drying. Furthermore, this outer half is marked by four deep furrows running longitudinally and converging at the apex like the four halves of a hickory nut exocarp. In fact this half of the nut has, externally, all the appearance of a hickory nut, though the furrows above mentioned do not extend entirely through to the endocarp. This outer half of the nut is also smaller than the basal half, giving the latter somewhat the appearance of a deep acorn cup into which the outer half is sunken slightly. Thus there is a transverse groove at the meeting of these two halves and extending back for a millimeter or more under the basal exocarp. So closely did this basal and apical half resemble a walnut and a hickory nut respectively that the parties who found it were certain that the nut was the result of a cross between these two genera, though they had no further evidence than the appearance of the nut for this supposition.

Within a few weeks of the time this nut was reported a similar one was sent to Professor Barnes from southern Tennessee.

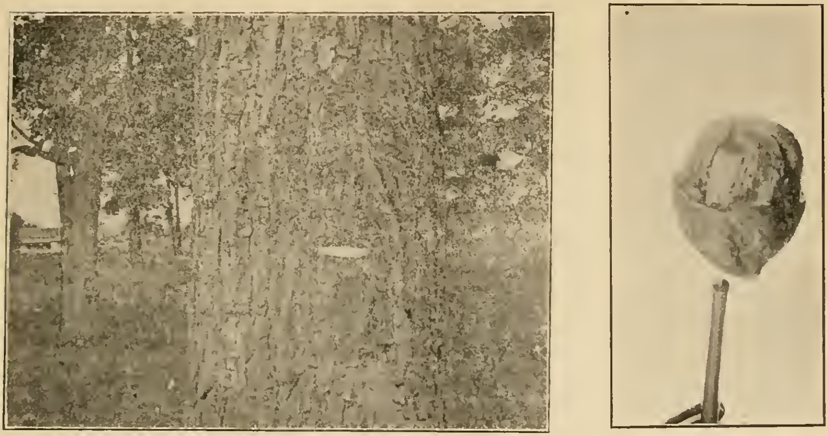

Fig. 2. Tree and nut of aberrant walnut from Indiana.

The specimens above described were turned over to me for investigation. I endeavored to get more material from these trees but the parties owning them or knowing of them had only a layman's interest in the same, and could not be induced to collect any material, except for one collection of nuts from Tennesee in the fall of 1905. Being located either in New York City or Salt Lake City, I was unable to visit either tree. Last summer, through the assistance of the Carnegie Institution of Washington, I was enabled to visit each tree and obtain photographs of them.

The Indiana tree is growing in a natural open grove of walnut, oak and hickory trees. It is probably forty to fifty years old and free from branches to a height of eight or nine meters. The crown is not large and has all the aspect of a *Juglans nigra*. The bark as well as the leaves are also, superficially at least, walnut in their characters. Growing about thirty meters from this tree are a couple of hickory trees (*Hicoria minima*, Marsh, Britton) each fully a third younger than the walnut. The peculiar nuts were found in 1903, and, according to statements of parties living near, the tree has borne some of these nuts nearly every season since.

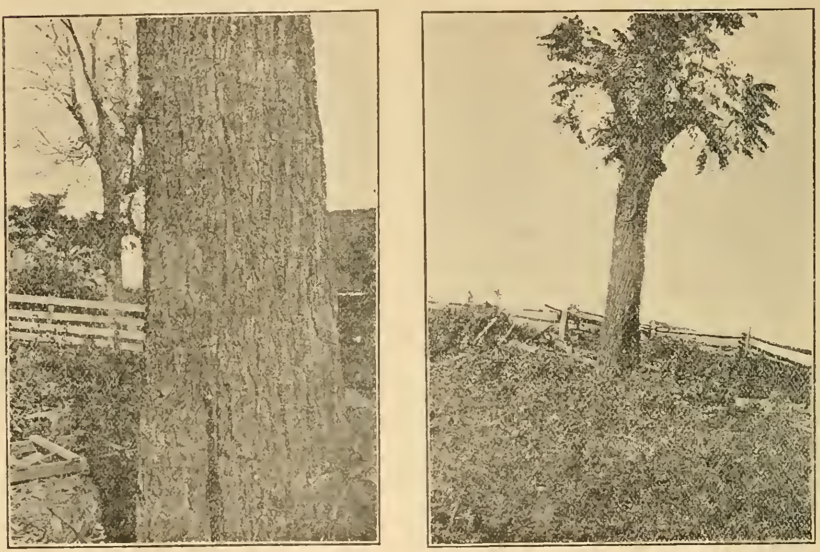

Fig. 3. Aberrant Walnut from Tennessee.

The Tennessee tree is growing on a roadside in front of a dwelling, though it is probably native,as the immediate vicinity was originally a walnut-hickory-oak woods. It is probably sixty to sixty-five years old and at one time had a large crown, the first branches of which were five to six meters from the ground. Last year the owner of the tree, for some inexplicable reason, topped it, so that the tree bore no fruit this year. This tree has been in possession of the same family for two generations, and, to the knowledge of the owner, has borne these peculiar nuts practically every season for forty years.

In connection with the idea that these nuts might have been caused by cross pollination and fertilization from a hickory, it is interesting to note that a hickory tree grew seven or eight meters from this tree until five years ago, but the tree continued to bear these peculiar nuts for four years after the hickory was cut down. A hickory, twenty to twenty-five years old is now growing about 30 meters from the "walnut" tree in question, but only three meters from this hickory grows a walnut, twenty-five to thirty years old, which produces only normal walnuts. Of course this idea of cross pollination can scarcely be entertained on account of the fact that it is that portion of the nut which is produced by the parent sporophyte that shows the "hybrid" characters. The bark of this Tennessee tree shows some hickory characters and it is possible that the histological characters, when examined, will indicate a cross.

Not all the nuts show the *equal* division into a "walnut" and "hickory" exocarp. In some the hickory-like portion occupies but a small area (six to eight millimeters in diameter) at the apex. In others this occupies a fourth of the apical part of the nut. In still others the division between the two kinds of tissue is not transverse but runs up much higher on one side than on the other. All of the nuts examined, with one exception, show the characteristic walnut endocarp. One nut, however, has an endocarp very closely resembling that of the bitter nut hickory (*Hicoria minima*, Marsh, Britton) while the exocarp is walnut in its characters. Some of the nuts also show peculiar marks, resembling leaf scars, on the projecting edge of the basal or "walnut" half of the nut.

Arrangements have been made for getting material and growing the same and it is proposed to make a careful study of the problem from all view points. The purpose of this preliminary report is chiefly to call attention to these plants and request anyone having information of similar plants to report the same. Any such information or facts regarding any unusual behavior in the fruiting of walnuts will be gratefully received.

Washburn College, Topeka, Kansas.

PLANT ASSOCIATIONS OF THE DESERT LABORATORY DOMAIN AND ADJACENT VALLEY

BY V. M. SPALDING.

(*Concluded.*)

(8) SUPERFICIAL SOIL LAYERS; ASSOCIATION OF ANNUALS.

Thus far, attention has been directed wholly to perennial species which, rooted in their places and remaining there for a period of years, constitute the more permanent and conspicuous elements of the vegetation. There are, however, a very considerable number of annuals which, at certain seasons of the year, become a highly characteristic and conspicuous constituent, and whose habits and distribution involve interesting and important problems. As in the case of the general association of perennial plants of the hill, we are here dealing with a more or less composite biological group, which, however, covers a wider area, and is perhaps even more influenced by distinctively local conditions. This, in its turn, will be studied to best advantage under several groups, which, though not sharply delimited, are sufficiently well defined. Taking the winter annuals first, three divisions based on physiological requirements are recognized.

(*a*) *Shade-loving species.*

A good representative of this group is *Parietaria debilis*, which grows luxuriantly in the continuous shade of rocks on northern exposures. The water content of this plant is very high, the stems have the shining pellucid appearance of the eastern clearweed, and there are no indications of specially developed means for the prevention of excessive transpiration. Though designated as shade-loving, because of its almost exclusive occurrence in the deep shade of rocks, there is, nevertheless, evidence that its growth here is conditioned by moisture, rather than lessened light intensity. It ventures here and there a little beyond the shade, and though strikingly modified in form and structure by exposure to full insolation for a part of the day, it is nevertheless capable in this situation of maturing seeds. It is apparently a plant of the same physiological requirements as the so-called shade-loving species of mesophytic forests, and in the one case as in the other it may well be questioned whether in the complex of physical factors necessarily involved, light intensity plays as important a role as has been attributed to it. In any case, it is to be understood that the classification here adopted is retained chiefly for convenience in discussing observed facts.

A number of species of winter annuals grow luxuriantly on northern slopes and in the shade of rocks and bushes that are hardly met with on full southern exposures. Such are *Bowlesia lobata* and, to a less marked degree, species of *Phacelia*, *Amsinckia*, and others. Study of the habits of these plants, however, indicates quite as plainly as in the preceding case, that the water relation is of primary importance. *Bowlesia*, for example, which has grown thickly in the shade of a creosote bush or palo verde, continues, when they are destroyed, to produce new crops year after year on the same ground, where the accumulation of humus insures a better water supply. This and the other plants just named are entirely capable of successful growth in the full light of the sun, provided the root-system is still in soil that supplies a sufficient amount of water. The light relation, notwithstanding the apparent choice of shade on the part of these species, appears, therefore, to be subordinate to water supply as a factor determining local distribution.

(*b*) *Light-loving species.*

Many of the winter annuals of Tumamoc Hill grow everywhere in the open, where they are fully exposed to the sun, and to a greater or less extent, also, where there is some shade; such are species of *Harpagonella*, *Pectocarya*, *Plantago*, *Daucus*, *Erodium*, and other genera. These also are far more numerously represented on northern than on southern exposures, but from the fact that the range of light intensity under which they habitually accomplish their normal development is so great, there can hardly be any doubt that the local distribution of these species, like that of the preceding sections, is correlated first of all with water supply; and far less, if indeed to any appreciable degree, with light intensity.

In its ultimate analysis, therefore, the local distribution of the winter annuals here represented is fundamentally based on the water relation. So broad a conclusion should receive confirmation from the determination of physiological constants involving a prolonged series of experiments, but the appearance or non-appearance of both these and the summer annuals is so obviously related to rainfall that any other conclusion as to their relation to water supply is, with present evidence, impossible.

The summer annuals appear after the summer rains, during the period of the highest temperature of the year. Once the ground has become wet they germinate and develop with great rapidity,some of them growing to a large size and in such numbers as to form, in many places, a conspicuous feature of the vegetation. They bear the same relation to summer rains that the winter annuals do to winter rains, and their behavior necessitates the same conclusion as to the fundamental importance, in their case as in that of the winter annuals, of the water relation.

Not less certain, however, is the fact that the habits of both are directly correlated with differences of temperature. It is impossible, for example, to induce the germination of the seeds of winter annuals in summer temperatures, unless they have previously been subjected to a low temperature. Thus while water supply, with annuals as with perennials, is a chief factor in determining distribution in space, differences of temperature determine with remarkable precision and certainty the distribution in time of the winter and summer annuals, and the face of the landscape is twice a year changed to correspond with their biological habits. It results that areas which are densely covered with winter annuals in February and March afford ample room and all the necessary conditions of development to the luxuriantly growing summer annuals of August and September.

(9) PARASITIC AND SYMBIOTIC PLANTS.

Though not forming associations properly comparable with the foregoing ones, the parasitic plants of the Laboratory domain call for notice. Two species of mistletoe are widely distributed in this region, one of which, *Phoradendron californicum,* is of fairly frequent occurrence on Tumamoc Hill and th adjacent valleys, where it grows on *Prosopis velutina,Parkinsonia micropyhlla*, *Cercidium Torreyanum*, *Acacia constricta* and *A. Greggii.* Of these *P. microphylla* and the mesquite are its most frequent hosts on the domain, where it has been observed but once on *A. constricta*, and once on *Cercidium Torreyanum.* The other species, *Phoradendron flavescens*, has not been found within our limits, but it is of common occurrence in the valley of the Santa Cruz River in the vicinity of Tucson, growing on cottonwood and ash trees.

In contrast with the limited number of hosts which are here affected by these species of mistletoe, Mr. J. C. Blumer states that in the Chiricahua Mountains, at altitudes of 5,000 to 6,000 feet, he has observed *Phoradendron flavescens* growing on two species of ash, on sycamore, on two species of cottonwood, and on two of willow, and in its form *pubescens* on many oaks. This is as might be expected from the far greater variety of hosts and the greater ranges of environmental conditions in the mountain region.

Important observations and experiments have been made on both species by Cannon, to which bare reference can here be made. These relate to germination and mode of penetration of the host and to the rate of transpiration of the parasite as compared with that of the host. In regard to the latter it was found that in the various experiments undertaken the parasite transpired more rapidly than the host, from which there results an unnatural draft on the resources of the host, which is often followed by the death of the infested branches, the consequent great disfigurement of the tree, and, in some cases, its ultimate destruction. It does not seem, however, that any of the hosts affected have been appreciably limited in their distribution by the action of these parasites. As for the distribution of the parasites themselves, it appears from the observation of the author referred to that it takes place from tree to tree by the agency of birds, but its distribution in a tree is such as to indicate that when once the higher branches have been infected,in due time seeds from this source reach the branches below without the agency of birds.

An exceedingly interesting case of parasitism, in which a large number of hosts is involved, is that of *Orthocarpus purpurascens palmeri*, which in springtime grows so thickly on the sides of Tumamoc Hill as to give them a reddish tint noticeable at considerable distances. Dr. Cannon has identified some 20 species of plants on the roots of which this parasite fastens.

As far as present observations extend, the fungus flora of the Laboratory domain may be characterized as insignificant.

A few parasitic forms of the Perisporiaceæ and other groups occur from year to year on certain annuals, and a few saprophytes have been found on bark, and, in two or three instances, growing in the low ground of the wash. Undoubtedly careful search would result in the collection of a considerable number of species, but the fact remains that the fungus flora here is extremely limited, as it would seem it must be from the severe conditions imposed. This meager showing is again in contrast with the rather rich display of fungi reported by Blumer in the Chiricahuas, and probably matched in other neighboring mountain regions where favorable conditions prevail.

The symbiotic plants constituting the lichen flora have been studied by Prof. Bruce Fink, to whose papers on this subject reference should be made.

(10) CULTIVATED GROUNDS, WASTE PLACES, AND ROADSIDES; MISCELLANEOUS INTRODUCED SPECIES.

Within the limits of Tumamoc Hill and the adjacent flood-plain the introduction of weeds and of various cultivated species has gone on until these have become, in many places, a conspicuous and more or less important element of the vegetation. The high mallow (*Malva parviflora*) and cocklebur (*Xanthium canadense*), for example, have greatly modified the aspect of roadsides and edges of fields. Along the arroyos *Arundinaria*, and near the old mill quince-bushes and *Sapindus* are permanent reminders of the planting of earlier days. Among later arrivals are the afilaria (*Erodium cicutarium*) and foxtail (*Hordeum murinum*), both of which have made themselves at home, and their presence is materially felt over wide areas.

The physiological requirements of these and numerous other species introduced here, as well as their distribution in relation to local conditions, are, to all appearances, much the same as in the different regions from which they came, but it is noteworthy that they exhibit comparative indifference to intense insolation, much like indigenous species already referred to that commonly grow in shady places. With one group as with the other, a sufficient supply of soil-water is evidently the first essential, and, with this assured, they flourish in the fierce glare of the sun in an atmosphere often of very low relative humidity.

REVIEW OF THE PLANT ASSOCIATIONS.

It has been seen that the plant associations and habitats of Tumamoc Hill and the adjacent valley fall naturally into four well-defined groups, namely, those of the river, of the flood-plain, of the slopes, and of the hill.

Associations of the river.—These are two in number: first, the aquatic plants of the river itself and the irrigating ditches fed from it, and second, the species of the river-banks. These latter include not only willows and cottonwoods, but arrow-weed and some other species characteristic of the arid Southwest. The small number of species belonging to both of these associations, in comparison with those of corresponding habitats in regions of greater rainfall, is significant. It is apparently due to two causes; first, the greater difficulty which seedlings encounter in starting where the water-supply is intermittent, and second, the high rate of evaporation in connection with the inconstant water-supply.

Associations of the flood-plain.—No associations are more characteristic than the two which belong to the flood-plain of the Santa Cruz and other rivers of the same region, nor could there well be a case in which the delimitation of the smaller area occupied by one of these associations from the larger one in which it lies is more clearly referable to special conditions. In this case accumulations of alkali salts, commonly in areas of defective drainage, constitute the essential peculiarity of the habitat of the salt-bushes.

Outside of these areas the flood-plain is the habitat of an association composed of two groups of plants of very different biological requirements. These are, on the one hand, the mesquite and *Acacias*, whose long roots extend to depths where a sufficient water-supply is assured, and on the other, the *Bigelowia* and various other plants of low growth, the roots of which occupy more superficial soil-layers and are, as far as the soil relations are concerned, subjected to more distinctively xerophytic conditions. These differences of ecological requirements in plants closely associated on the same ground are of fundamental importance as regards competition.

Associations of the slopes.—To this group belong the creosote-bush association, the palo verde-catclaw association of the wash and the association of *Franseria* and cholla, which (within our limits) occurs just beyond the wash on the west half of the Laboratory domain. Each of the three is characteristic and well-defined. They are evidently determined by soil relations, in which water-supply is a dominant factor.

The different behavior of certain species of these associations as regards strict maintenance of habitat choice is especially worthy of note. While the catclaw, for example, hardly passes beyond the limits of the wash, the creosote-bush not only invades this, but grows there far more luxuriantly than within its own special habitat. The relations are complicated, but it is plain that this behavior of the creosote-bush is the result of a greater capacity of adjustment on its part to differences in amount of soil-water than is possessed by such plants as the catclaw and palo verde.

Associations of the hill.—Up to this point it is manifest, even upon casual observation, that soil relations have had a preponderating influence in determining the different associations of plants and their limits. On coming to the hill, however, it is apparent that another factor, namely, aspect, or direction of slope has also exerted a marked influence in determining the composition and place of several of the associations. This is seen with special clearness in the case of the *Lippia* association and that of the sahuaro and *Encelia farinosa*, the former occurring here exclusively on north exposures, the latter well represented only on the east, west, and especially on the south sides of the hill. Plants of the two remaining associations are entirely indifferent to aspect, and in this respect stand at a decided advantage.

The association of annuals, belonging to superficial soil-layers, though well represented on the hill, is not confined to it. Temperature and soil-water are obviously the factors which determine the appearance in their seasons of the plants composing the two widely different biological groups of this association.

To avoid unnecessary diversion the parasitic, symbiotic, and miscellaneous introduced species are here omitted from discussion. Excluding these, there are in the four natural groups that have been described 12 well-defined associations of plants exhibiting habitat preferences which, on the evidence obtained from careful observation, must be correlated first of all with soil-water, but in some cases quite as clearly with temperature. Other factors, especially aeration and percentage of alkali salts, apparently have a dominant influence in one or more of these associations.

NOTES UPON THE CLEARING AND STAINING OF LEAVES AND STEMS.

BY L. M. PEACE.

Leaves and stems of the higher plants, which have been dried, or kept in formaldehyde or some other of the usual preservatives, often have been bleached and cleared with the greatest difficulty, when they were wanted for histological studies. It was found that the materials varied in their susceptibility to the different methods of clearing. In general, the worker had to try all of the known methods in order to find the one which would satisfactorily bleach and clear his material. If he were studying some plants, such as those of the desert, which plants usually contain much coloring matter, he may not have found any method altogether satisfactory.

Of the methods in general use, only Eau de Javelle will clear some of these plants, but the employment of this reagent is undesirable, since it may destroy the tracheal elements of the tender leaves and young stems. When examined with the microscope, small leaves, which have been cleared in Eau de Javelle, often show no traces of the tracheal elements of the veins.

After considerable experience with the various well known bleaching and clearing reagents, it has been found that all kinds and conditions of available leaves and stems, or sections of leaves and stems as the case may be, are readily and satisfactorily bleached and cleared by the following method:

Place whole leaves, if they are small, or parts of them if they are large, and sections of stems as the case may be, for from one to three days or a week, in a saturated aqueous solution of chloral hydrate; rinse thoroughly in water, and place for a similar length of time in a five per cent solution of potasium hydrate. The specimens should now be thoroughly bleached and cleared of all cell contents. They may now be transferred to seventy per cent alcohol, dilute glycerine, or to a saturated aqueous solution of chloral hydrate, where they may remain until wanted for study, or for further treatment.

If the material clears with difficulty, the process may be hastened, by first treating the specimens for twenty-four hours or over night, in a ten per cent aqueous solution of hydrocloric acid, and then proceeding in the usual way. The whole process of clearing may be further facilitated, by keeping the reagents containing the specimens upon the paraffine oven, or in some other warm place.

It is sometimes advisable to treat the specimens with a weak solution of acetic acid when they are removed from the potassium hydrate, in order to remove all traces of this reagent. A thorough washing in water, however, will render the acid bath unnecessary.

The length of time for treating leaves with chloral hydrate, may be determined by an occasional examination of them. As soon as they are colorless or transparent, they must be passed to the potassium hydrate. Some material, however, would never become colorless with any treatment with chloral hydrate. Leaves of desert plants have been boiled and incubated for months in chloral hydrate, with the result that they seemed more deeply colored than they were at the beginning.

The length of time for treating leaves and stems with potassium hydrate,may be governed by examining them occasionally with the microscope. , Twenty-four hours are ample for many of the ordinary specimens.

Leaves and stems cleared in this manner, show their cell wall structure better than when treated in any other way. Bits of leaves and sections of stems so prepared are very satisfactorily studied without staining, when temporarily mounted in concentrated chloral hydrate or dilute glycerine.

It is desirable, however, to stain them by the following method: Prepare a deep red stain by dissolving safranin in a saturated aqueous solution of chloral hydrate; stain the whole leaves or parts of leaves in this for a few hours or over night; rinse in water, bleach in concentrated chloral hydrate for a few moments, or until the stain is removed from all of the tissues except the tracheal elements of the veins; wash in water and transfer to dilute glycerine, where the specimens may remain indefinitely, or be mounted in glycerine jelly. Whole leaves treated in this manner make beautiful studies in leaf venation. If the staining is properly done, the tracheal elements will be of a deep transparent red color, while all of the remaining tissues will be transparent and unstained. In some cases of ordinary leaves, it is not necessary to bleach out the stain with chloral hydrate; a half hour or longer soaking in water will suffice.

If cross sections and tangential sections are wanted, dehydrate, and embed bits of the cleared leaves in paraffine according to some of the usual methods. Sections may now be cut upon the microtome, fixed to slides in the customary way, but stained in the manner just outlined.

Stem sections are treated in exactly the same way as are leaves, when a single stain is all that is desired. When stems treated in this way are properly stained, all lignified, suberized and cutinized cell walls will be of a deep transparent red color, while all cellulose cell walls will be transparent and unstained.

Leaf and stem sections thus bleached and cleared, should be double-stained as follows: Stain for a few hours or over night, in a concentrated aqueous solution of chloral hydrate deeply colored with safranin; rinse in water, and transfer to concentrated chloral hydrate, where they remain until the stain is removed from all cellulose walls; rinse thoroughly in water, and stain for five to sixty seconds in a saturated aqueous solution of Bismarck brown; rinse quickly in water, and transfer to dilute glycerine, where the sections may remain indefinitely, or be made into permanent mounts in glycerine jelly.

When the specimens are fixed to the slides, the Bismarck brown is better applied by holding the slide in one hand, while the sections are flooded with the stain from a dropping bottle pipette in the other hand. The Bismarck brown will readily stain some specimens within five seconds, but will take a longer time for others. The worker will have to experiment in order to adapt the time to his specimens. In using this stain, care must be taken in order not to overstain. If this be done the Bismarck brown will mask the safranin.

If the double staining has been properly done, the lignified cell walls will be of a deep transparent red color, the suberized and cutinized cell walls will be transparent and red to a degree in proportion to the extent to which they have been suberized and cutinized, while the cellulose cell walls will be yellow or of a brownish-yellow color.

Specimens bleached and cleared in the manner just outlined, may be readily stained by any of the general methods of staining, and mounted in Canada balsam or any other medium at hand; but no method surpasses the one just outlined for the treatment of leaves and stems, when a detailed study of their cell walls is desired. With this treatment, every detail of structure such as pits and primary cell walls stands out boldly. In the preparation of specimens for lantern projection, camera lucida drawings and for making photomicrographs, it is to be highly recommended.

A NEW ROCKY MOUNTAIN BOTANY. *

By H. M. Hall.

Twenty-five years ago Professor John M. Coulter gave to the botanical public his *Manual of the Botany of the Rocky Mountain Region.* This has now been thoroughly revised and brought down to date by Professor Aven Nelson, of the University of Wyoming. Although Professor Coulter's work was confessedly tentative, since it treated of a little-known district, it has been of inestimable value, especially in that it has incited many western plant lovers and botanists to look more critically into their interesting flora.

It should be remembered that a local or regional flora need be neither absolutely complete, infallibly accurate, nor based upon an extensive personal acquaintance with the plants themselves. Such complete works are, to be sure, greatly to be desired and may well serve as an ultimate aim, but there is an immediate call for tentative accounts based upon scattered publications and giving our present knowledge of the species treated, together with artificial keys to aid in their determination. Such compilations not only assist in making identifications but encourage the gathering of materials and data for more critical and exhaustive studies.

If we look upon Professor Coulter's manual as a pioneer in this field, we may consider this revised edition as marking a new epoch in the history of Rocky Mountain botany. Collectors and students have been very actively engaged during the interim; new species and forms have been discovered and described, many of the older ones have been critically studied and their relationships determined, our system of nomenclature has been gradually evolving, and all of these features have conspired to make the preparation of a new flora exceedingly desirable. But to bring all of this scattered work together must have involved an infinite amount of labor and patience. And it is very humiliating to admit that this labor has been greatly increased by the rapid and careless work of many so-called systematists. Perhaps no large area has suffered more from errors due to superficial studies and lack of coordination of results than has this western part of North America. The tourist collector, the local botanist aspiring to fame, the eastern and European specialist who often fails to realize the great range of variation in our ecologic conditions and the resulting plant forms, have united in loading us down with a wealth of synonyms and disconnected, unrecognizable "species" which is appalling. In preparing a flora it is necessary to look into these proposals, selecting and incorporating the good, rejecting and reducing to synonomy the bad. This, we may well imagine, was the most troublesome task which Professor Nelson had before him, and the *Manual* reflects the results of his discriminating labor.

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*New Manual of Botany of the Central Rocky Mountains (vascular plants), by John M. Coulter, Ph. D., Professor of Botany, the University of Chicago, revised by Aven Nelson, Ph. D., Professor of Botany, the University of Wyoming. 646 pages. American Book Company.

As a test of the extent to which reductions have been made, the reviewer has gone carefully through the Compositae, in which 538 species are recognized. He finds, in this family, that 283 species proposed since the issuance of Gray's Synoptical Flora in 1886 are here treated as straight synonyms, 16 species have been reduced to varieties, while 12 are mentioned as being insufficiently known. Meanwhile 186 species proposed during the same period are accepted. To the total of 311 species rejected, reduced, or merely mentioned, must be added, however, a considerable number of recently proposed species which are in no wise accounted for, presumably from Professor Nelson's inability to comprehend them from the descriptions, so that nearly two-thirds of the new species of Compositae proposed in the last twenty-four years have already gone by the board.

Professor Nelson's summary is also illuminating. According to this, 2733 species are accepted in the whole book, while 1788 synonyms are cited. No attempt has been made, however, to cite all of the synonyms, and since many of those mentioned are old proposals this gives but little clue to the value of recent work. From these results, especially those mentioned for the Compositae, it would seem that the species-making mill has been grinding altogether too fast, especially when we consider that as the flora becomes better known and intermediate forms are collected, the number will be still further reduced rather than increased.

The aim throughout seems to be to steer a middle course, accepting all real contributions to knowledge but rejecting all attempts at artificial species-making. The author's evident desire to see fair play is well shown in his commendable readiness to reduce his own earlier species in the few cases where this seems desirable. In fact, the spirit of the work throughout impresses one as a sincere attempt to express truth, while the errors are due to a lack of facilities or of time for making more exhaustive researches. It is regrettable that the author could not have added to the intimate field of knowledge of his flora a study of types in the larger eastern and European herbaria. There are also several institutions in the west where much information concerning the species to be included and their distribution was readily obtainable. The literature on Rocky Mountain botany might also have been more thoroughly explored to advantage, especially the papers of Miss Eastwood, Professor M. E. Jones, and Mr. Brandegee. However, the omissions can be readily pardoned in view of the splendid work accomplished.

As in the acceptance of species, so in the treatment of genera the author has shown moderation. It is a pleasure to find such well known genera as Pinus, Saxifraga, Astragalus, and Mentzelia retained in their entirety, as in the older treatises. On the other hand we find accepted such segregates as Batrachium and Halerpestes from Ranunculus; Drymocallis, Argentina, and Horkelia from Potentilla; and ten genera created out of Oenothera. In following the Vienna Rules of Nomenclature, "so far as practicable," many time-honored names which would have been changed under the so-called American rules, have been retained. It is the opinion of the reviewer that if they had been followed more closely and more consistently the book would have gained in value and popularity. The retention of the name Compositae for the whole Sunflower family, including the Cichorieae and the Ambrosieae, will meet with almost universal approval.

The region covered by this work is that of the central Rocky Mountains. It aims to describe all of the species occurring in Colorado, Wyoming, Yellowstone Park, and the Black Hills of South Dakota, and covers also the most of Montana, southern Idaho, the eastern half of Utah, and the northern half of New Mexico and adjacent Arizona. All botanists throughout the Pacific states will find it helpful in their work.

The descriptions are carefully drawn, care being used to include the essential characters without useless waste of space. The general distribution of each species and variety is given but specific localities are not mentioned. One of the most pleasing features of this flora consists in the compact and intelligible keys, not only to the families and genera but to the species as well. They are dichotomous in the main and may be easily followed, even by the beginner. Professor Nelson is to be congratulated on having given us a very valuable and useful treatise on the botany of this interesting region.

University of California.

BOOKS AND CURRENT LITERATURE.

Among the more important data and conclusions of a recent paper by Leroy H. Harvey on The Floristic Composition of the Vascular Flora of Mt. Ktaadn, Maine (Mich. Acad. Sci. 1909), are the following: The arctic-alpine element of Mt. Ktaadn includes 118 species which constitute 54 per cent of the total flora of the mountain. Of these 118 species, 67 occur in Arctic Europe and 42 in Arctic Asia; but of the 67 Ktaadn species in common with Arctic Europe only 24, or 35 per cent are known in Arctic Asia, while of the 42 Ktaadn Asiatic forms 34, or 80 per cent, are common with Arctic Europe.

From these and other data previously set forth by Hooker and others, it appears that Arctic Europe is the main center of glacial distribution, and that from this two prominent routes, the Asia-Alaskan and the Greenland-Laborador, may be designated. Arctic Europe is to be considered as the center of distribution of the Ktaadn alpine flora, and the glacial migration was dominantly by the Greenland-Laborador route.

The Mistletoe Pest in the Southwest is discussed by Prof. William L. Bray in Bulletin No. 166 of the Bureau of Plant Industry (1910). A list is given of thirty-two species of plants which serve as hosts of the mistletoe in Texas. A curious habit of the parasite is exhibited in the prevalence of infection upon different species in different localities. Thus the sycamore, upon which the mistletoe has not been reported in Texas, is one of the most commonly infected trees in the river bottoms of Arkansas, as it is also in Southern California. At San Antonio and southwestward the mesquite is the chief mistletoe host, while the water oak at Bryan, and the osage orange in northeastern Texas are specially subject to its attacks, and so on.

Passing beyond the limits within which the author's observations were made, it is instructive to note that the mistletoe family, as a whole, shows a progressive development of parasitism from the Australian Nuytsia, a non-parasitic tree, through the "half parasitic" mistletoes of Europe and the United States to the degenerate, absolutely parasitic *Phrygilanthus aphyllus*, which lives on a species of Cereus in Chile.

The MacMillan Company of New York (66 Fifth Ave.) have recently issued a new "Manual of Gardening," by Prof. L. H. Bailey, which is designed to be a practical guide to the making of home grounds and the growing of flowers, fruits and vegetables. In addition to a lucid discussion of various classes of plants and their culture, treatment for disease, etc., in the garden, lawn, and window garden, some valuable hints are given as to the laying out of grounds and the execution of landscape effects. The book is profusely illustrated and is probably the best small handbook on the subject yet issued.

In the PLANT WORLD for May, 1908, a résumé was given of the work of Dr. H. Winkler of the Botanical Garden at Tuebingen, Germany, in producing forms that appeared to be graft hybrids between the tomato and black nightshade. Shoots arising from callused regions in which the tissues of stock and cion had grown together showed a Mosaic or a fusion of the qualities of the two parental species.

Five distinct forms were easily made out, which the author designated as *Solanum tubingense, S. Gaertnerianum, S. Koelreuterianum, S. Darwinianum*, and *S. proteus*. When seeds produced by these various forms were sown, the progeny of any type was composed completely of plants almost identical with the parental species which the graft hybrid resembled most closely. The second generation was thus composed of tomato plants from some of the hybrids and nightshade from others.

The plants derived in this manner, however, were not entirely like the nightshade and tomato which were originally united, but displayed some modified characters, which are possibly beyond the range of fluctuating variability.

While it is clear that no fixed hybrids were produced by Winkler, yet the end result is similar to that of Mendelian crosses. The final decision as to whether or not the types produced are to be regarded as true graft hybrids, must rest upon the results of cytological investigations now being carried out by Winkler.

Prof. Bateson's treatise on "Mendel's Principles of Heredity" recently re-issued by G. P. Putnam's Sons of New York, has been received. The accumulation of information bearing upon alternation of inheritance and segregation of characters has now reached a point where this book of four hundred pages is necessary to set forth some of the more important experimental results and conclusions. To those who question the validity of the Mendelian ideas and doubt their capacity for wide application, the list of structural characters in which studies have been made, will be an "eyeopener."

The development of modified ideas as to the behavior of "unit characters" and a better understanding of dominance as a phenomenon of heredity, has widened the usefulness of the Mendelian theories, and given all workers definite and exact methods by which both theoretical and experimental research may be carried forward profitably.

It would be a mistake, however, to suppose that even the most ardent Mendelianist would claim that all characters in a cross egregate in the offspring. The mulatto, or cross between the white and black races of men, affords a most notable example to the contrary, while diverse hybrids of the population of Mexico exemplify the same principles abundantly. The author has at his command an enormous amount of information concerning heredity of color in animals and plants some of which is well described in this volume. So far, the Mendelian ideas have been of but little use to the breeder, but the practical application of the information now available, would doubtless result in the shortening of the long, tedious, and costly experiments by which many new econ mic varieties are customarily built up.

NOTES AND COMMENT.

In an abstract of a lecture on the San Bernardino Valley in Torreya for January, there appears the following:

"The moisture brought by the Pacific winds is precipitated in crossing these mountains during the winter season only. At the greater elevations, 10,000 to 12,000 feet, it is deposited as snow; lower,in the form of copious rains,and in the valley itself in a more or less scanty rainfall. During this period moisture is not carried to the great interior plain of Nevada, Utah, Colorado, New Mexico, and Arizona, where a dry season then prevails. In the summer, conditions are exactly reversed, no rain whatever falling west of the mountains."

A glance at a map to be found in any high school, and five minutes consultation with the publications of the U. S. Weather Bureau, would reveal to the author of this statement some startling discrepancies in his conclusions, since the great plains mentioned offers the most diversified topography to be found in North America, and it has two rainy seasons. Over much of this area the precipitation is greater in winter than in summer.

The Chief of the Weather Bureau has issued a pamphlet for the enlightenment of the Committee on Agriculture of the

House of Representatives, entitled "The Influence of Forests on Climate and Floods." Professor Moore's paper is rather subversive of opinions that have been long and widely held, indeed he states "I formerly held different views on this subject and I reserve the right to change or still further modify them if the presentation of new facts and figures renders such a course logical, and I do not consider that I will stultify myself in so doing."

The principal contention of Professor Moore is that deforestation does not tend to cause floods, although this main thesis is very much confused throughout the paper with the relation of deforestation to rainfall, in which much learned opinion is brought to witness that portions of the globe are treeless because their aridity does not permit the growth of trees, rather than because of the lack of trees inhibiting rainfall. "It is not believed that the cutting of the Cedars of Lebanon had any thing to do with the dryness of the valley of the Jordan." It is further stated as proven that cultivated soils retain water as well as a forest cover does and that snow melts much more suddenly and rapidly in forests than in the open. Quotations from every quarter are brought to demonstrate that the number of floods has not increased in recent years with the increase of deforestation. It seems particularly unfortunate that two pages should have been quoted from a French engineer which can be summed up as showing that "in the basin of the Seine there has been a gradual and constant decrease in the height of floods with the diminution of forests."

The only serious attempt to prove that floods are no greater after deforestation is made on the basis of the figures for rainfall and for river stages in the Ohio Valley from 1871 to 1908. A comparison of the figures for the first and second halves of this period shows an almost exact agreement, but the figures for the river stages are mean monthly amounts and give no indication whatever of the height of the maxima or lowness of the minima in the curve of the daily fluctuation in the river's flow. As if to be more exact a second table is given showing the number of days that the Ohio and Tennessee were above the flood stage, but giving no indication of how high they were above stage on any particular day or series of days. It is almost as meaningless to compare two 19-year periods since 1871 as it is to compare two consecutive years. If the Chief of the Weather Bureau were able to get the figures of river stages at Cincinnati from 1771 to 1789 and would compare them with those for 1890 to 1908 he would find out what it is that he formerly believed and that he may come to believe it again.

Desert lichens on north face of rocks, Tumamoc Hill, Tucson, Arizona.

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THE ARCTIC-ALPINE FLORA OF PIKE'S PEAK.

BY BLANCHE SOTH.

Pike's Peak, above timberline, is divided naturally into two physiographic types, the glacial amphitheaters and the meadows, with their variations, bogs and rockfields. It is chiefly upon the meadows that the abundant and variable flora must be studied, as the sheer-walled glacial chasms are almost inaccessible and the paucity of their vegetation scarcely repays the collector for the labor of their exploration. Nevertheless they are of considerable interest to the student and a few words describing them may not be amiss.

There are six of these glacial depressions upon the slopes of the peak, the "Crater" and the "Bottomless Pit" being the best known and most accessible. Their perpendicular walls and beetling crags extend downward for more than two thousand feet in places, and it is only upon the floors which slope upward for a little distance from timberline and in the cracks and seams of their walls that plants have been able to establish a foothold.

Probably the glaciers in their retreat left a little fine ground rock waste upon the narrow, jutting ledges and some has rolled down from above, but by far the greater part of the present soil of the walls is wind blown. The gales which sweep the sides of the great central cone of the peak are so violent and long continued that a considerable accumulation of gravel may be noticed in the sheltered spots after a single storm. I have known the wind to blow with a velocity of from fifty to sixty miles an hour for ten days without stopping, and it often attains a much higher velocity for a short time. When it is remembered that a velocity of twenty miles an hour blows up dust, it can be understood how effective is the force of the wind upon soil and vegetation above the protection of the timber.

These wind deposits are moistened by seepage from the melting snow above and augmented by the decay of vegetation carried in by the birds which nest in the crevices, so that a soil capable of sustaining the high alpine plants has gradually accumulated. The species are the same as those which inhabit the rockfields and ledges, with occasionally a few meadow plants on the wider ledges, and evidently have been carried in by the winds and the birds. The species of the floors of the chasms do not differ from those of similar altitudes without. The floors of both the "Crater" and the "Bottomless Pit" are below timberline and do not slope upward enough to bring them into the alpine zone. In the case of those which do rise above timberline, the species from below merge gradually into the dominant alpine forms.

The alpine meadows are formed upon the accumulating blanket of rock waste which is slowly creeping up the sides of the mountain. It covers the tops of some of the hills below 13,000 feet, dips over the saddle and extends somewhat interruptedly to the very summit of the peak itself. In general these fields are dry and wind-swept, and their vegetation low and matted. They are broken, however, by rocky ledges outcropping on the hilltops, rockfields, gravel slides, bogs, gulches and shallow depressions occupied by rivulets which have their origin in the numerous springs and in the melting snows of the higher ridges. To these variations of environment are due the variations in the size and structure of the plants, which astonish those who imagine that the upper region of Pike's Peak is a barren waste of rock.

The rock ledges and the fields of broken rock blocks which extend down the sides of some of the hills have a vegetation of their own. The soil, which has accumulated in pockets between the tumbled blocks, sometimes to a considerable depth, is mostly wind-blown and therefore very fine; it is protected from the sun and the full sweep of the winds and is continually moist. The characteristic species, therefore, are tall and sometimes rather succulent plants and mostly occupy their space to the exclusion of other species. Even when the xerophytic meadow plants are found growing here they exhibit a much larger growth, especially of leaf surface.

No doubt a large factor in the distribution of seeds over the entire zone is the habit of the little animals, which live in the cavities between the rocks, of carrying in great quantities of seed-bearing plants for winter use. I have seen as much as a cubic foot of this material in a single heap and counted fourteen species of plants so collected. The stalks are cut off close to the ground, carried to the rocks and deposited in sheltered nooks, reminding one of miniature haystacks.

Springs appear at the lower edges of the rock fields and, if the slope is not great enough to allow the water to run off, boggy areas are formed which also have their own peculiar flora. Often, however, the water runs away in little rills, and so only moistens a portion of the dry meadow. Certain species are partial to these localities, but in general they are characterized by the unusual size and vigor of the usual dry meadow plants.

The areas of the gravel slides are not yet covered with vegetation,only a few tentative pioneers having established themselves along the edges. *Rhodiola integrifolia* is the first species to occupy these spaces and the last to leave territory being smothered by a slide. Evidently its long root-stocks push under the gravel while drawing nourishment from the parent plant outside the arid area, and thus it survives where other plants can not.

The gulches, with their rocky sides and marshy bottoms, repeat the variations of the meadows in a very limited area and exhibit all the characteristic alpine species within a few hundred feet in the course of the season. These variations merge gradually into one another,so that it is only in certain localities that typical societies are found, and all the species are thus widely distributed over varying soils and exposures. Few of the plants show any preference for any certain slope; I have never found *Dryas octopetala* on a south slope and *Saxifraga chrysantha* prefers a northerly exposure, but it is to be found sparingly in other situations. In general, the plants grow wherever other conditions permit without regard to this feature. The spring-blooming plants follow the snow line and the same species which bloom in June on sunny southward slopes at timberline may be found in August in the deep gulches north of the peak, where the sun never shines.

Even the casual observer notes that the meadows are covered with ring-like spots from two to six or even ten feet in diameter. During the growing season these rings exhibit a greener, ranker growth than the surrounding meadow, while at other times they are conspicuous by reason of the reddish color of the dried foliage. This peculiar appearance is due to the species *Sieversia turbinata*. Examination shows that the center of the ring is occupied by a more or less disintegrated boulder, with often a stunted shrub or pine, whose usual habitat is much lower. Probably the coarse rock fragments prevent evaporation to some extent and the products of the disintegrating granite supply an element of fertility to the soil. Thus the area protected supports a larger growth and the lusty Sieversia has crowded out its more adaptable companions, although it very obligingly permits the harebells and a few individuals of other species to inhabit the gravelly space within its ring.

In the neighborhood of the saddle (altitude 12,600 feet) are to be found some species whose normal habitat is near timber line, for example, *Penstemon stenosepalus*, *Carduus scopulorum* and *Chamaenerion angustifolium*. Their presence here is easily accounted for, however. The "saddle" is a depression between the main mass of the peak and the spur known as Sachett Mountain. The warm air from below, rising along the sides of the mountain, finds here the first crossing point,and so there is a continual current of air passing over the saddle from below and such seeds as are easily carried by the wind are borne aloft and deposited here. The area is well watered by seepage from the hills on each side and the temperature is probably moderated a little by the ascending air currents so that these plants mature their blossoms in favorable seasons. I doubt whether the seeds ever mature where the frosts come so early,but the colonies are kept from extinction by yearly deposits of seeds from below.

Spring, summer and autumn are quite distinct. Spring is characterized by the blooming of such species as *Thlaspi coloradense* and *Eritrichium argenteum*, which require but a few days of bright sunshine to bring them to the blooming stage. These plants complete their growth after blooming and examination in the autumn reveals the rudiments of the next years' blossom tightly curled up in the heart of the plant. Digging them from under the snow as early as April one finds them green and already lengthening the flower stock. I do not suppose they are ever totally unresponsive to sunshine and a warmer day than usual, even in winter, causes them to unfold a little and, as their roots do not penetrate far below the surface, water from the melting snow furnishes additional stimulus. Probably they merely curl up and suspend animation during the colder days and are ready to burst into bloom as soon as the first bare slopes appear. Indeed, I have often found *Thlaspi coloradense* pushing fully expanded blossoms through the snow at the edges of the drifts. Summer, from about the first of July to the middle of August, marks the height of the growing season and all the characteristic alpine species are in full bloom. Autumn is characterized by the ripening of the grasses and the blooming of those species which have crept up from below timber line. These plants withstand a noticeable degree of frost and are mostly such as the gentians, whose reproductive organs are well protected; but even as late as November a few warm days after quite severe weather will bring out quite unexpected blossoms of *Potentilla saximontana* and *Cerastium occidentale.*

The autumn landscape above timberline is by no means cheerless. The deep blue sky is overhead; the yellow grass beneath, sloping down to the green of the pines and the red and orange and gold of the aspens, is broken by dense splashes of blue harebells and creamy gentians, while away on the horizon tower the glistening white peaks swimming in the purple haze of Indian summer.

THE TRANSLATION OF DE VRIES' MUTATION THEORY.

BY D. T. MACDOUGAL

The first American review of the mutation theory was printed in Torreya in 1902 (MacDougal, D. T., Torreya. May, June, and

July, 1902), and the appearance of the translation of the first volume of this important work (Open Court Publishing Co., Chicago), affords a fitting opportunity to measure the progress of the ideas presented by its famous author. The arrangement of the present edition was made by Professors Farmer and Darbishire in England, which will do much to lead to a fuller consideration of DeVries' work in that country. There, as well as in America, the earlier presentation of the idea of discontinuous variation was met with a fine show of prejudice and unbelief, and a tendency was noticeable to prove or disprove its conclusions by citation from Darwin's writings.

To those most familiar with the broader meanings of the work of the elder Darwin, it would seem that were he alive he would have been among the first to welcome conceptions in which the nature of qualities or characters was more clearly defined and would have encouraged any procedure looking toward the formulation of ideas as to calculable heredity.

The original publication of the mutation theory was shortly followed by Prof. DeVries' visits to America where experimental tests were first made in substantiation of his results with the evening primroses. By means of lectures,personal meetings and conferences, a large number of Americans quickly gained an idea of the more important features of the mutation theory. A course of lectures at the University of California, which were edited and brought out in a volume under the title of "Species and Varieties" (also published by the Open Court Co.), was still more effective in making known the salient points of the most important contribution to evolutionary science since the appearance of Darwin's Origin of Species. This book with its non-technical treatment of a difficult subject has been most appropriately translated into Dutch, German, Italian, and must eventually be rendered into French and Russian.

The promulgation of the theory and the description of the experimental methods by which the evidence supporting it was obtained, has stimulated thought and research in evolution enormously. The attention of scores of workers in laboratories and cultural establishments has been turned to the testing of various corollaries of the subject, and as has been repeatedly stated, heredity has been definitely brought within the domain of experimental science. The result has been the accretion of a body of evidence showing that discontinuous variation leading to the possible production of new forms is not confined to the evening primroses, and while it seems more common among plants, evidence from animals is not lacking.

Not the least interesting result of the whole movement has been the awakening of a vast chorus of voices crying the virtues of special interests and controverted theories. Those busy with vitalism of various types, have spun a moiety of the tenuous web of their favorite fabric. Isolation and geographical distribution have again been advanced as the prime factors in species making. Natural selection with diverse meanings has been called upon to account for all evolutionary development. Orthogenesis has once more had its creed re-stated, and Lamarckianism, with its predication of the inheritance of acquired characters has again come into the limelight, with the result that its claims seem about to be tested experimentally as has not been done before.

It is as if all these claimants had been called before the bar of public opinion for a re-hearing as to the validity of their theses. It would be singular if the standing of some of the ideas represented were not altered in such comprehensive review and revaluation.

The appearance of the translation of the mutation theory with its original records of experimentation, will make the technical evidence upon which its generalizations are based, accessible to a great constituency of workers and will do much to remove prevalent misapprehensions concerning some of the principal features of the theory.

OPERATION OF THE POROUS CUP ATMOMETER.

BY BURTON EDWARD LIVINGSTON.

The porous cup atmometer, for measuring evaporation,was first devised in its essentials, by Babinet in 1848 (Compt. Rend., 27:529-30), but attracted no particular attention. *

It was independently devised by Mitscherlich (Landw. Versuchs. Stat., 60: 63, and 61: 320, 1904) and also by the author,

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*The literature of evaporation is brought together in an annotated bibliography of the subject published by Grace J. Livingston in the Monthly Weather Review. 1908-09.

in the latter case for use in studies upon plant transpiration at the Desert Laboratory. The scattered literature on the use of this instrument comprises the following references: Livingston, Publ. 50, Carnegie Inst., 1906; Plant World, 10: 110, 269, 1907; *ibid*, 11: 1, 106. 1908; Science, N.S., 28: 319. 1908; Proc. N. Y. Hortic. Soc., 1907; Transeau, Bot. Gaz., 45: 217. 1908; Amer. Nat., 43: 487. 1909; Shaw, Amer. Nat., 43: 420. 1909; Gager, Month. Weath. Rev., 36: 63. 1908; Yapp, Ann. Bot., 23: 276-319. 1909. While the instrument has proved satisfactory in many ways and in the hands of many operators, yet its use has entailed a number of difficulties, and it is with the obviation of some of these latter that this paper has to deal.

Correction of readings.—The main objection to unglazed porcelain as an evaporating surface is that, even though good distilled water be exclusively used (as should always be the case), the salts of the clay gradually migrate to the outer and upper portion and clog the pores to a greater or less extent, thus reducing the effective surface from which evaporation may take place. With high rates of evaporation, as in the desert, the effect of this clogging may often be detected after a week or two. In more humid regions the effect is less marked, while in a nearly saturated atmosphere it may practically vanish. With excessive evaporation the reverse is found to be true with some cups, and salts are, for several weeks at least, drawn from the interior to the surface of the cup, where they crystallize in a frost-like coating and are blown away by the wind. The result of this appears to be that the more soluble constituents of the clay, which it seems practically impossible to wash out with water or acid, are removed, leaving the walls somewhat more porous and thus, relatively, increasing the rate of water loss. It is obvious that an evaporating surface which thus capriciously varies in its effective extent is highly unsuited to the measurement of the evaporating power of the air, and this condition of affairs makes it advisable, as has been mentioned in earlier papers, to restandardize the cups as frequently as possible. This should be done at least once a month and is desirable at intervals of a week or two. According to this plan, a standardized cup is placed in position, allowed to operate for a period, and is then replaced by another standardized cup. During the period of operation of the second cup the first cup is restandardized, and is ready to operate during the third period, the second cup being then restandardized for use in the fourth period, etc. Thus, for a season's work in the field, it is necessary either to be almost continually at work with standardizations, or to provide at the start a sufficient number of cups so that a newly standardized one may be exposed at each station every month or oftener. By the latter plan, each used cup, when taken from the instrument, is allowed to dry naturally and then wrapped in paper and preserved till circumstances allow all to be standardized together.

The value of the observations depends so largely upon the standardization that this second test can never be safely omitted, unless, indeed, the cups have been only a few days in operation. Cups which are tested at short intervals for several months, at the Desert Laboratory, showed that the change in the correction coefficient progresses nearly continuously and nearly uniformly and it is this fact which makes the method of repeated testing practicable. Experience has shown that for habitat and general climatic studies, the errors introduced are practically negligible if the cups (otherwise, of course, properly treated) are tested each month. The weekly or daily readings for the month are corrected to standard by the average of the two coefficients obtained before and after the exposure of the cups, unless the cups show a great change (over ten or fifteen per cent.), in which case the interpolated coefficients may be calculated on the assumption that the variation has progressed uniformly throughout the month. Thus, if the original coefficient of standardization for a given cup be c and the coefficient obtained after four weeks' operation be c', c and c' not differing by more than, say, 0.10, then the corrected reading, E, for each week, is obtained by multiplying the actual reading, R, by $\frac{c+c'}{2}$, or $E=R\frac{c+c'}{2}$. When $c-c'$ is greater than 0.10, we may correct for the first week by the following formula: $E=R(c+\frac{c'-c}{n})$, for the third week by: $E=R\left(c+3\frac{c'-c}{n}\right)$, etc., where n is the total number of weeks and the numerical coefficient of the fraction (3, above) is the serial number of the particular week considered.

Standardization.—The first method of standardization used was to allow the cups to be tested to operate near a standard cup, reading all daily for several days, and to calculate the average coefficient of correction for each cup as referred to the standard. This method is objectionable for two reasons. First, the standard cup changes with use and this change can not be directly detected nor determined. Secondly, where several observers wish to standardize to the same standard, their standards must previously have been compared. This necessitates a central station for standardizations.

To obviate these difficulties a method has been devised by which every cup is standardized to a free water surface. Since the rate of evaporation from such a surface varies, not only with its area, but also with the nature of the vessel and with the volume of water contained, it is necessary to fix upon some arbitrary standard. The apparatus used during 1909 is constructed as follows: The basal portion of a Petri dish, 1.5 cm. high and 9.25 cm. in diameter inside,is placed on the rectangular base of a small iron stand of the usual form, a piece of asbestos board, 10 cm. square and 5 mm. thick, being inserted between dish and metal. Above this, its neck resting in the dish, is clamped an inverted cylindrical mixing bottle (250 cc.), previously filled with distilled water. The bottle is then raised till the water stands just 3 millimeters deep in the dish. It will remain at approximately this depth till the bottle is emptied. The outside diameter of the bottle neck where it meets the water surface is 3 cm. The total area of the dish being 67.20 sq. cm. and that of the bottle neck 7.10 sq. cm., the area of water actually exposed is 60.10 sq. cm. The bottle needs filling every few days, this being done by removing from stand. Care must be had that the bottle is properly replaced. Evaporation takes place from the exposed surface and is measured by weighing the entire apparatus at intervals of 24 hours. A "Harvard trip" balance has been used for this, weighings being made to 0.2 gram. Four such evaporating pans are operated in a row, about 50 cm. apart, and the average loss from the four is considered the standard. These stand on a table in the greenhouse or in a closed room (to avoid air currents) and the cups to be tested are arranged around them about 25 cm. apart and an equal distance from the pans. The cups are mounted as heretofore, but in ordinary 6 or 8 ounce bottles, which bear a file mark on the neck. At each observation the bottle is filled to the file mark, from a burette, and the amount of water required is the reading for that period.

It was found that the standard cups of 1907 and 1908 evaporate only 0.75 as much as does one of these pans, so that, in order to render the work of various years directly comparable, the actual standard used in calculation of the coefficients is not the average loss from the pans, as above stated, but this quantity multiplied by 0.75. A standard cup may be defined as one showing a loss of 0.75 as much as the average of the four pans described above, the comparison being made without air currents. Sunshine affects cups and water surface alike, so does not alter the relation. Thus, the standard cup loses water at about the same rate as 45 sq. cm. of water surface exposed as above.

The calculation of the coefficients of standardization has been performed as heretofore, three-fourths of the average loss from the four pans being treated as the reading of the standard cup. Thus, if the four pans lose in 24 hours P_1, P_2, P_3, and P_4 grams of water, respectively, and the cup to be tested lost L cubic centimeters, the coefficient for that cup would be

$$C = \frac{L}{\frac{3}{4} \times \frac{1}{4}(P_1 + P_2 + P_3 + P_4)}.$$

This coefficient is expressed in two places of decimals; it is the number by which the reading of the cup must be multiplied to give the reading of the standard cup.

Since the evaporating power of the air for any particular station can be determined for comparative purposes only by means of the two coefficients of correction, it has been found well to have a formal record for each cup. This is a slip of paper bearing the number of the cup, the original coefficient and the date of testing, a note of the use made of the cup, and the final coefficient with its date. The table of losses from the several cups in operation shows the cup numbers as well, so that reference to the coefficient record slips gives all the necessary data for correction when the results are to be calculated.

Reduction of corrected readings to depth.—Evaporation has been measured like rainfall, in units of depth, centimeters or inches. This method has arisen from the desire to give evaporation rates in terms of loss in depth from lakes, ponds, etc. But of course the soil varies to a marked degree in its power to give off water, this power depending on the water content, the fineness of the soil, the vegetational cover, etc. Thus the records in inches or centimeters are supposed only to denote an hypothetically possible evaporation, if the whole area considered were a water surface. However, even this does not approach the truth; the depth, the kind of sediment and other factors enter into the phenomenon of natural evaporation from water bodies. Also, it has long been known that the form, size and material of an evaporating pan exercise a great influence on the rate of evaporation. Therefore, if this climatic factor is measured in terms of depth it is necessary that the water surface referred to be accurately described. It has often been suggested that the readings of the porous cup atmometer should be reduced to centimeters or inches of evaporation. This can be done, but only with reference to a more or less arbitrarily chosen water surface. This point is clearly brought out by the following considerations. The standard cup loses one gram for each 0.2217 mm. in depth of the standard pan, which contains approximately the volume of water held in the cup and has a surface approaching that of the uncoated instrument. This is a very small volume with a relatively large surface. Comparison with a hemispherical copper pan about 25 cm. in diameter and 12 cm. deep gives 0.1416 mm. in depth as corresponding to one gram from the standard cup. Comparison with one of the two-foot pans in use at the Salton evaporation station of the U. S. Weather Bureau (the operation of which I was able to study for several days in June, 1909, through the kindness of Prof. Frank Bigelow, in charge of this work), gives 0.137 mm. as equivalent to a gram from the standard porous cup. Thus we see, it is only through a standard pan or tank, arbitrarily chosen, that units of depth come to possess any meaning at all, and it makes no difference what units are used so long as the standard is comparable throughout the series and so described that other observers may duplicate it.

Coating of cups.—It has been found highly advantageous to coat the basal portion of the cups with some water-proof material, partly to avoid clogging of the pores through handling (which should always be done by the coated portion) and partly to diminish the effective evaporating surface and hence the water loss. For humid regions, merely the enlarged rim is coated; for regions of great evaporation, about one-half of the cup is coated. More than three-fourths of the cup should not be coated in any case, since a very rapid clogging of the active surface follows such treatment, at least at the Desert Laboratory. This seems to be due to the accumulation in the active portion of soluble material from the entire cup. New cups coated to within three centimeters of the tip have often proved impossible of standardization, the coefficient on successive days rising rapidly from about 1.50 to numbers as great as 12 or 15.

Of course the end desired is that the loss for a period (as a day or a week) be large enough so that errors in reading, etc., may be minimized and, at the same time, that an excessive amount of distilled water be not required in the operation. At the Desert Laboratory in June a standard cup loses from 80 to 100 cubic centimeters per day.

A great deal of difficulty was met with in finding a suitable substance for forming the coating. Paraffin scaled off, as did also shellac. Shellac is somewhat soluble in water; various varnishes, enamel paints, and Kotinsky cement are markedly soluble, as is also white sealing wax. Cups coated with these soluble materials show sooner or later an area of resinous matter at the tip of the cup, this area gradually increasing, with a corresponding rise in the coefficient of correction. One of the best substances found was red sealing wax. This is but slightly soluble, and cups treated with it showed no migration of the material to the tip even after months of use. There was no appreciable clogging in the case of red sealing wax. Cups coated with red wax and then painted with white enamel paint gave very satisfactory results. They possessed the desirable white outer surface and the wax prevented the solution and migration of the soluble material in the paint. Of course the paint must not extend at all beyond the wax.

By far the best substance so far tested for coating the cup is sulphur. The material is melted to its most liquid form (not too hot), the heated cup is plunged into it, and the surplus sulphur is brushed off with a hair brush. These coatings have a dull greenish-yellow color, perhaps an undesirable feature, but they operate perfectly. There is no evidence of solution.

Of the ordinarily obtainable and easily applied substances, natural shellac in alcohol is by far the best.

Micro-organisms in the cups.—Fungi grow excellently upon the instruments in a moist atmosphere, and there is little doubt that bacteria also occur, especially on the inner surface. To prevent the growth of these forms a number of treatments have been tried, but nothing is as satisfactory as to rinse the cup with weak mercuric chloride solution before installing. It is true that this adds some soluble salt to the cup, but no after-effects on the coefficient have been detected. Dr. Forrest Shreve informs me that a solution of copper sulphate is also suitable. Formalin can not be used on account of the inevitable presence of paraformaldehyde, which clogs the cups.

Duplication of instruments.—It has been found desirable to operate two or three cups for each station, placing them side by side about 50 cm. apart. Accidents to several instruments are not likely to occur simultaneously and the attainment of an unbroken record is made more probable by this means.

Renewal of clogged cups.—This may often be accomplished by grinding. The clogging occurs mainly at the outer surface and this semi-glaze may be completely removed by setting the cup in a lathe (by means of a rubber stopper on a metal rod held by the chuck) and holding fairly coarse sandpaper about it as it revolves. The sandpaper must not be used too long, otherwise the glue of the paper and the heat generated will form a new glazed surface. Cups may be scraped with freshly broken glass or merely rubbed with sandpaper, or they may be ground on an emery wheel. A great many cups which would otherwise be discarded can thus be ground, and after re-coating, will operate as well as new ones.

Preparation of distilled water for the atmometer.—Ordinary distilled water is apt to prove injurious to the cups in time. For this use the water should be as carefully prepared as for accurate chemical analysis. No natural water has been found at all possible for this work. Many records have been lost through attempts to use natural water. Distilled water may be transported in the field in heavy tin canteens, which should be crimped together, and soldered on the outside with rosin and no acid.

Correction for absorption by rain. A new form of instrument has been described in the Plant World, 13:79, 1910, by the use of which rain-water falling upon the cup can not enter the reservoir, thus removing one of the greatest objections to the porous cup as an ecological instrument in humid regions.

The Johns Hopkins University,
Mar. 2, 1910.

BOOKS AND CURRENT LITERATURE.

Scharfetter, in the Austrian botanical Zeitschrift, discusses the poverty of species, especially Alpine species, of the eastern extensions of the central Alps, which is attributed to the following causes: 1. The uniformity of the geological substratum. 2. The limited extent of the areas lying above tree line. 3. The limited variety of habitats. 4. The close associations which have covered the ground since the Glacial epoch and have been a hindrance to the entrance and establishment of outside species.

Engler's Contributions to the Flora of Africa, XXXV, 1909, includes an instructive account of the discovery of a representative of the Triuridaceae in West Africa and the geographical relations inferred therefrom. The seeds of these saprophytic plants are quite incapable of distribution by ocean currents, and the family is therefore to be regarded as of great age, extending back to the Tertiary, beyond the time of the first occupation of the continents by the rain forest, and to a time when the Seychelles, where this family is still represented, was connected more closely with the main land.

Guelinger, in the Beihefte Bot. Cbl., 1909, brings to completion his extended study of the distribution of plants in the limestone region of the southern Alps. Orographic, hydrographic, geologic and climatic factors are discussed in their relation to the various types of vegetation, each of which is considered at length under the several formations, or associations, belonging to it. In conclusion, four vegetative regions are distinguished as follows: 1. The submontane region, with its upper limit at 1,000 to 1,050 meters, the forest cover of which is characterized by the oak-hornbeam, and chestnut associations. 2. The montane region, from 1,050 to 1,700 meters, distinguished by beech forest and meadow. 3. The subalpine region,the upper limit of which is placed at 1,900 to 1,950 meters, less sharply defined than the preceding, but characterized, in part, by its larch forest and several associations of shrubs which here reach their upper limits. 4. The Alpine region.

Herzog has recently published (Engler's bot. Jahrb.) an account of the vegetation of Sardinia in which both the plant associations and geographical relations are discussed at length. The Sardinian flora includes 1,560 species of Phanerogams and Vascular Cryptogams, of which 613 are classed as Mediterranean, 78 west Mediterranean, 115 south Mediterranean, 49 tyrrhene, and endemic in Sardinia, 16. There remain 678 species classed as non-mediterranean, including numerous widely distributed grasses, water plants and cosmopolitan species. Comparison of the flora with those of Corsica and Sicily shows that they are fundamentally alike in their Mediterranean elements and that a considerable number of endemic species are common to these three islands. A nearer relationship of older endemic species is noted between the floras of Corsica and Sardinia than between those of the latter and Sicily; but the exclusively insular and younger endemic species show a greater nearness between Sardinia and Sicily, as if their floras had developed largely in more recent times under similar conditions. The composition and peculiarities of the alpine floras suggest that in Sardinia the settlement of alpine elements took place before the separation of the two islands, while in Corsica their migration continued much longer.

Prof. H. H. Dixon and Mr. W. R. G. Atkins, of Trinity College, Dublin, have described a thermo-electric method of determining freezing points of solutions in the scientific proceedings of the Royal Dublin Society for February, 1910, by which they are able to determine the osmotic pressure of sap of plants very readily. Twenty-three species were tested by the new method and it was found that the osmotic pressure varies considerably in different individuals of the same species and in the same individual under different circumstances. The leaves showed an osmotic pressure of nearly 27 atmospheres while the roots, which generally had a much lower pressure, ranged from four to six atmospheres. The authors surmise that the leaves of Syringa may have the sap concentrated by evaporation to a pressure of 30 or 40 atmospheres before they begin to wilt.

Strakosch, in the Berichte of the Vienna Academy, contributes a short paper on the climate of Egypt and the Egyptian Soudan from the standpoint of photochemistry. He concludes that the chemical intensity of light in that region does not increase proportionally with the height of the sun, and that at a given height of the sun it is less than in Middle Europe. This is attributed to the infrequent rains in Egypt and the Soudan. Fine particles of dust which rise to great heights and the greater nearness to the equator with its thicker atmospheric strata are also held to be factors.

Jaccard's earlier researches on the floral distribution of alpine meadows have been supplemented by later studies of subalpine meadows. His work has been conducted on natural meadows at a height of 1,200 meters, in theWoadtlaender Alps, where 52 areas, each containing one square meter, were employed in the investigation. His work is reported under the following heads:

1. Elementary floral differences.
2. Relative frequency of the species of an association.
3. Relation between local and general frequency.
4. Curves of local frequency on the meadows of the southern Jura.
5. Relative general frequency.
6. Individual frequency.

7. The generic coefficient.

8. Relative relation of the great groups of the plant kingdom.

9. Resume.

According to the author an association is to be considered as an organic unit; its constituents exhibit a definite correlation, and their relative occurrence as regards number and kind presents a constancy which is in striking contrast with the variation in external conditions to which they are exposed. The distribution of species in a given plant formation results from the combined operation of three groups of factors: 1. Ecological factors (climate and soil); 2. Biological factors (means of adaptation); 3. Sociological factors (competition and accommodation.).

Pitard and Proust have recently published an extended account, in a work of upward of 500 pages, of the flora of the Canary Isles (Paul Klincksiek, Paris), from which it appears that the flora of theCanaries includes 1,352 indigenous or spontaneous species. Of these 350 are reckoned as ubiquitous, 534 as belonging to the Mediterranean region, and 468 as endemic or Atlantic. The ubiquitous species are chiefly temperate, though a relatively small number are tropical. The endemic elements are connected especially with Mediterranean species, others have African affinities, and some rare Atlantic types have their nearest relatives in America or eastern Asia. The endemic forms, including varieties, species and genera, represent three successive degrees of intensity, with which the climate and insolation have acted on Mediterranean types resulting in their modification. The proportion of endemic genera is equalled or exceeded only by St. Helena, Juan Fernandez, the Sandwich Islands and New Zealand.

Hayek, in treating of the xerotherm plant relicts in the eastern Alps, describes the occurrence of numerous colonies of thermophilous plants which belong to an earlier period in which a warmth-loving flora had settled in this region. The colonies located in the heart of the Alps, formerly covered with ice,are necessarily of post-glacial origin; while those on the edge may have arisen in inter- as well as post-glacial times.

The more extended studies of Briquet on the post-glacial return migrations of the Swiss floras (Trans. Swiss Soc. Nat. Hist.), beginning with the last inter-glacial period, go to show that during the final period of glaciation the vegetation of the forested region was almost wholly driven out of Swiss territory, while the alpine vegetation found six territories of refuge on the north, northwest, east and south. On the return of the Swiss floras after the last period of glaciation there were as many lines of migration as there had been territories of refuge. The characteristics of the several floras along the lines of later migration present data from which important conclusions may be drawn. The flora of the Engadine, for example, is such that it can be explained only by the existence of a post-glacial warm and dry period, the so-called xerotherm period.

Hochreutiner, in a recent publication of the botanical garden of Geneva, gives the results of his elaborations of several collections of Madagascar plants. He concludes that this island has received many of its plants by three successive immigrations, as follows: 1. An ancient one of long duration from the east, during which plants settled in the low region of the east coast and adjacent tropical territory. 2. An African immigration, more recent, but interrupted for a time long enough for new species of close affinity and numerous varieties to arise. Many plants of the high plateaus of the island are closely related to those of south Africa. 3. A still more recent immigration continuing to the present time determined by marine currents from insular India.

Yapp, in a paper in the Annals of Botany, discusses the relation of stratification in the vegetation of a marsh and evaporation and temperature. It was found that the air in the midst of the vegetation was more humid than that outside and that very considerable differences in humidity existed between the lower and upper strata, and that the higher strata of vegetation are subject to greater diurnal range of temperature than the lower layers or the free air above.

Preuss, under the title of "The boreal-alpine and pontic associations of the flora of east and west Prussia" (Ber. d. Deutsch. bot. Ges.), discusses the reasons for considering that a large number of boreal-alpine plants are relicts of the post-glacial tundra periods, while others came in later with birches and other trees from the east, rather than at a still later period, as assumed by Weber. His view is based in part on geological evidence, such as the fact that habitats particularly rich in boreal-alpine species are chiefly found in regions of terminal moraines, and in part on the character of the vegetation and of the plant associations of those habitats which excludes the view that a fortuitous migration of single species into the northeastern lowlands could have resulted in the present composition of the flora. Further evidence is drawn, also, from the biological peculiarities of the species in question, which inhabit moors in which the large percentage of water present and the water capacity of the soil result in lowering the temperature and shortening the period of growth under these conditions. *Salix myrtilloides*, for example, a sensitive species, could not have appreciably extended its limits in the North German lowland within historical time, but is rather to be considered as a relict of an epoch whose climatic conditions approached those of higher latitudes.

Raunkiaer has reported in the Memoires of the Denmark Academy the results of his studies of the Strand vegetation of some of the Danish West Indian Islands as compared with that of similarly situated land in Denmark. He lays special emphasis on temperature and on humidity originating from precipitation in determining the character of strand vegetation.

Something over a dozen years ago a cruciferous plant was found growing wild at Lindau, Germany, which resembled *Capsella bursa-pastoris* but differs from it in various characters to an extent that led Solms-Laubach, after making trial cultures,to designate it as a new species under the name of *Capsella heegeri*. The mode of its occurrence suggested its recent origin from *Capsella bursa-pastoris* by mutation, and in 1901 it was mentioned by DeVries as an instance of mutation in nature. Solms-Laubach investigated the result of self-fertilization and showed that the characters that differentiate *Capsella heegeri* from *C. bursa-pastoris* are fully heritable. Shull, from whose recent paper on the crossing of *Bursa bursa-pastoris* and *Bursa heegeri* (Proc. 7th Intern. Zool. Congress, 1910) the above is quoted, has tested the question as to what will happen when the two species intercross and presents his results as follows:

(1) *Bursa heegeri* has the same Mendelian units in its leaves as occur in *B. bursa-pastoris*,which serves further to confirm its derivation from that form.

(2) The crossing of *B. heegeri* with *B. bursa-pastoris* gives rise to a series of elementary species in the former corresponding with those in the latter species.

(3) The leaf characters are inherited in strict Mendelian ratios, but the capsule shows a very great departure.

(4) Under these circumstances the capacity of *B. heegeri* for self-maintenance in competition with *B. bursa-pastoris* rests upon the comparative infrequency of cross-fertilization.

"The precipitation is distributed in different ways in the soil according to its nature and surface, and hence comes the division into formations; it therefore can not be said that one plant formation is edaphic and another not, on the other hand they may all be named edaphic, dependent as they are on the humidity in the soil; but as the humidity is dependent upon the precipitation, it is most natural to say that they are all climatic." All of which serves to indicate the part that dialectics may be made to play in investigations of this character.

The studies of West on the British Freshwater Phytoplankton, reported in the proceedings of the Royal Society, indicate a dominance of desmids in the lakes of Western Scotland, North Wales, and the English Lake District. It is found that the desmid flora increases in richness in passing from the Tertiary on the east to the older Paleozoic rocks of the western part of the

British Islands. The richest desmid floras are found where favorable habitats with abundant precipitation combine with a drainage water from the older geological formations. The factors, physical, or historical, or both, determining this call for farther investigation.

Ostenfeld, in his Botany of the Faroes, published in Copenhagen, gives an account of the vegetation of these islands in which he discusses the influence of climate and edaphic factors, the influence of man and animals, the biological characters of the various species, the natural plant formations and the formations in the cultivated areas. Among the most common formations are the moor, the heather moor, the cliff vegetation, and the rocky-flat formation.

Dickey has published in the Ohio Naturalist the results of his observations in a bog habitat. Climatological and evaporation data are given for the bog islands at Buckeye Lake, Ohio, which appear to be sufficiently exact and extended to serve as a means of comparison with similar habitats elsewhere.

From a review by Ostenfeld of his own observations of the immigration of *Biddulphia sinensis* and its occurrence in the North Sea it seems probable that this diatom was not carried there by currents but was brought from distant oceans by the aid of man, probably from the Indian Ocean by ship, attached to the outside or living in the water of the hold, or in the water of a bucket of a Hamburg steamer. The author gives details of its distribution and wanderings from 1904 to 1907, together with an account of its periods of maximum and minimum development and the position of its area.

Cook, in his account of the local adjustment of cotton varieties (Bull. 159, Bu. Pl. Ind.), assigns to local adjustment a much greater and more general agricultural importance than acclimatization. Failure to make use of it causes a general loss to the cotton industry represented by enormous totals. With very slight expense of time and effort in the selection of seed for local adjustment and with no other change, either in varieties, lands, or methods of culture, it would be possible to add 10 per cent or $60,000,000 to one cotton crop. The author discusses differences between local adjustment and breeding, the relation of the former to other variations, methods of introducing new varieties, relation of new place diversities to heredity, and other topics of theoretical importance. Among the conclusions that seem worthy of special notice is the following: It is not necessary to believe that the diverse characteristics that appear in a new place represent direct effects of the environment upon the plants. It is more reasonable to suppose that new conditions induce diversity in an indirect manner by disturbing the processes of heredity, and thus allowing ancestral characters that had been transmitted in latent form to return to expression, or characters previously expressed to become latent.

NOTES AND COMMENT.

The figure facing page 105 should have appeared in the April number of the PLANT WORLD as one of the illustrations of the paper of V. M. Spalding on Plant Associations of the Desert Laboratory Domain.

The notes on books and current literature in the present issue, which relate mostly to studies of distribution and the factors involved, have been taken chiefly from late numbers of the Botanisches Centralblatt with the thought that by their selection in this way the activity of students of distributional problems at the present time might be most impressively shown. As must always happen when papers from all sources relating to a given subject are considered together, they are of various degrees of permanent value. It is obvious, however, that conclusions based on superficial observation are more and more giving place to well considered and extended investigation, some of the results of which, notably, for example, those of Jaccard, are of far-reaching importance.

The amount of unwisdom on the subject of nomenclature which working botanists have had to put up with has been so great that by many the whole matter is refused a hearing, and in general this seems to be the only way to preserve one's peace of mind. A refreshing exception to most of the literature on this subject is a paper by Prof. W. G. Farlow on "A Consideration of the Species Plantarum of Linnaeus as a Basis for the Starting Point of the Nomenclature of Cryptogams."

The author assumes at the outset that the adoption of the Species Plantarum of Linnaeus (1753) by the Vienna Congress in 1905 made its acceptance as near universal as could ever be expected in such a case, and that this work may be taken as well adapted to serve as a basis for the nomenclature of Phaenogams. The cogent reasons adduced for this view should be sufficient, it would seem, to satisfy any reasonable being.

As regards the Cryptogams, however, the case is quite different. "One would be glad to adopt as a basis of nomenclature some one work which bears the same relation to Cryptogams as does the Species Plantarum to Phaenogams,but there has never been any such work and there never will be." For the fungi, however, which offer a better field for comparison than other groups, Professor Farlow suggests the Systema Mycologicum of Elias Fries (1821 and later) as better adapted than any other work, and records his conviction that in any case to go back earlier than the Synopsis of Persoon would only tend to perpetuate the present uncertainty and confusion and would open the door to those who, regarding nomenclature as an end in itself, and not merely a means by which the necessary evil of naming plants can be reduced to a minimum, devote time and labor to the undesirable task of unearthing names which at best are uncertain, at the sacrifice of names which have been in universal use for many years, and whose meaning is perfectly clear.

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THE COASTAL DESERTS OF JAMAICA.

By FORREST SHREVE.

During a recent visit to the island of Jamaica the writer made some short excursions to regions in the vicinity of Kingston which have the characteristic vegetation and physiognomy of deserts. These regions fringe the south coast of the island from the mouth of the Cane river, just east of Kingston, for a distance of about 70 miles to the Pedro Bluffs, having their largest area in the vicinity of Port Henderson, in the Healthshire Hills and in Portland Ridge. The desert-like character of these areas lying directly along the sea is due to a combination of climatic and soil factors which operate not only in Jamaica but in a similar manner on the coast of Cuba and San Domingo and in many of the smaller islands in the Bahamas and the Turks and Caicos groups.

The vegetation of the West Indian deserts bears a striking resemblance to that of the continental deserts in that it is made up of the same three ecological types, *i. e.* schlerophyllous shrubs, succulents and ephemeral herbs. The shrubs are the predominant type and they usually form a closed stand from 3 to 10 feet in height, making the appearance of the landscape quite unlike that of a continental desert or bush-steppe. There are three tall species of cacti which grow scattered among the shrubs in some places, or in others grow in closely crowded groups such as one can not see on the mainland north of Sinaloa or Zacatecas. The commonest shrubs of the Jamaican deserts are species of Acacia (*A. macracantha*, *A. Farnesiana*, *A. tortuosa*), the last two of which are also found in the deserts of Mexico and Texas, and several species of Cassia. The commonest and most conspicuous of the cacti is the "dildoe" (*Cereus Swartzii*), a columnar form growing to as much as 20 feet in height, a plant the gross physiology of which is probably very similar to that of the sahuaro (*Carnegiea gigantea*). The slender cylindrical form *Harrisia gracilis* (*Cereus repandus*) is strikingly unlike any of the cacti of the southwestern states, and the frequent *Opuntia spinosissima* is unique in having its crown of segments elevated upon an extremely spinose stem. *Melocactus communis* has the same form as the American barrel cacti (*Echinocactus* spp.), and is common, although not so conspicuous as the larger forms. All of the cacti and many of the thorn shrubs of the desert areas are not found outside them in the island, while the ephemeral plants are, so far as noted, species which grow elsewhere in the island and are not at all similar to the hoary and tomentose ephemerals of the continental deserts.

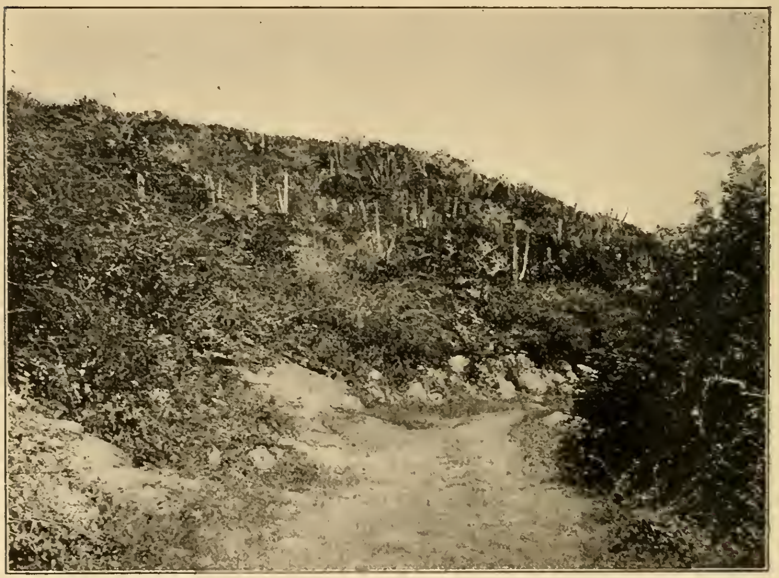

FIG. 1. Coastal Desert near Port Henderson, with the Dildoe (Cereus Swartzii) and species of Acacia and Cassia.

The alluvial valley which lies between the Healthshire Hills and the central complex of hills that forms the backbone of the island is a savanna region, bordered along Kingston harbor with a swamp made up of the mangroves *Rhizophora mangle* and *Avi-*

cennia nitida. The swamp merges into a series of saline flats covered with *Batis maritima* and *Portulaca pilosa.* Between the flats and the desert hills and stretching back between the flats and the savannas is a zone of thorn forest made up almost exclusively of a mesquite (*Prosopis juliflora*) known to Jamaicans as the "cashew." This tree is very similar to the American species of mesquite (*Prosopis glandulosa* and *P. velutina*) in habit and the details of leaf and flower, and is probably similar in possessing a deep root system enabling it to penetrate below the layers of soil impregnated with salts by occasional tidal overflow and to tap the underground seepage of fresh water from the interior.

The entire south coast of Jamaica receives a light rainfall, due to its being in the lee of the Blue Mountain range, which reaches elevations of 4,000 to 7,400 feet directly in the path of the prevailing north-east trade wind. Kingston, which lies in the desert belt, receives 32 inches a year, and the large desert areas to the west of Kingston undoubtedly receive much less. This low rainfall is capable of supporting a savanna of coarse grasses and large mimosaceous trees wherever the soil is deep, as is true in the vicinity of Spanish Town, Porus and May Pen. The desert, however, is sharply confined to limestone areas, which have an extremely rough surface with thin layers or shallow pockets of soil which are not capable of retaining moisture nor of deriving it by capillarity. The close proximity of the sea subjects these areas through the day to local sea breezes, and during the early part of the night to land breezes—the conditions being similar in fact to what they are in the small islands of the Bahaman group where the trade wind blows constantly but never discharges any of its moisture because of the low elevation of the islands. resulting also in a high percentage of sunshine. Soils similar to those of the Healthshire Hills which are situated in the northern and central parishes of Jamaica, where the rainfall reaches from 50 to 80 inches a year, support a lofty and diversified forest. It requires, in other words, the combined action of the low rainfall and the thinness of the soil to favor the desert vegetation.

The proximity of the sea and the existence of the sea breeze not only makes the atmospheric humidity of the coastal deserts much higher than in continental desrts, but it makes it relatively constant throughout the day and throughout the year. Half the annual average rainfall comes in two seasons, in May and June, and in October, the mid-winter and mid-summer being very dry. In spite of this unequal annual distribution of the rainfall the average monthly humidity of Kingston reaches no lower a minimum than 75 per cent. in April, and the annual average is 78 per cent. The writer has taken a number of humidity readings with a sling psychrometer in the deserts near the shore and at some distance back from it. These ranged from 74 to 77 per cent, in other words they were not far from the monthly averages for the weather station in Kingston. It was not practicable to obtain humidity readings at night, but it is probable that the falling of the sea breeze is counterbalanced in its effect on the humidity by the cool land breeze from the mountainous interior (locally known as the "doctor"), and by the fall in temperature during the latter hours of the night, resulting in a relatively level daily humidity curve.

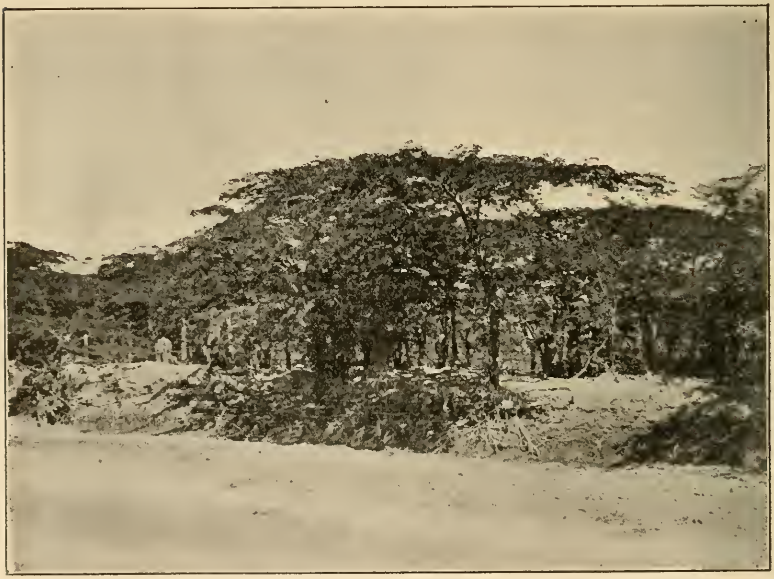

FIG. 2. A pure stand of mesquite, or cashew (Prosopis juliflora), in the savannas near Kingston Harbor.

During the first week of July, 1909, aporous cup atmometer was exposed in the desert at a spot quite near the coast between Cane and Hope rivers, and its reading compared with that of another cup at the Government Laboratories in Hope Gardens, * which are some six miles inland and behind a low ridge of hills. Both cups were exposed to full sunshine. When reduced to the amounts of loss per week from standard cups the readings are: for the desert, 175 cc., for the Government Laboratory, 148 cc. The location of the Laboratory subjected the cup there to several short periods of cloudiness, probably six or eight hours in all, while the entire week was clear at the desert cup; and operating in the same direction was the occurrence of a much more constant air movement at the coastal station. These factors amply account for the small difference in the readings, a difference which is quite incapable of serving to explain the difference between the vegetation of the coastal desert and that of the Liguanea Plain in the vicinity of the Laboratory. Some unpublished figures obtained by Livingston and Shreve relative to the evaporation rate in different parts of the United States show up the much greater contrast between the rates for continental deserts and for humid costal regions. The following are weekly rates, averaged from the four weeks of July, and are reduced to the same standard as those from Jamaica:

Tucson, Arizona	358 cc.
Miami, Florida	144
Cameron, Louisiana	167
San Diego, California	201

The rate for the Government Laboratory is nearly that for Miami, and the rate for the coastal desert is about half that for the continental desert at Tucson, while it is near that for Cameron which is situated on the Gulf coast and subjected to conditions of temperature and air movement not unlike those on the Jamaican coast. The San Diego reading is of interest as coming from a coastal region which partakes of the desert character in its vegetation; and while somewhat higher than the reading for the Jamaican desert it is still much lower than the Tucson reading.

While the leeward deserts of the West Indian islands are

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*I have to thank Mr. R. Simmons of the Government Laboratories for co-operation in the taking of evaporation readings through several months.

both ecologically and floristically related to the continental deserts they are nevertheless not to be looked upon as climatic deserts, but as edaphic areas of desert in a savanna region, belonging in the same category as coastal dunes. A relatively high and constant humidity gives the atmosphere an evaporating power which is more nearly that of humid coastal regions in the sub-tropical United States than it is that of the inland desert region of Arizona or even that of the semi-desert coast of Southern California.

A COMPARISON BETWEEN TWO MOUNTAIN SIDES.

By J. C. Blumer.

During a reconnaissance of the Rincon Mountains of southern Arizona in the summer and autumn of 1909, it early became apparent that a considerable difference in the plant covering existed between the two sides of the range. A similar difference has been detected in the Baboquivari and the Santa Catalina mountains. The Rincons are covered with a forest which at this altitude of 7,000–8,000 feet (2,100–2,400 m.) is composed in the main of *Pinus arizonica* and several evergreen oaks, with ceanothus underbrush and perennial and annual herbs and grasses, the perennials being dominant. To state briefly some of the points in categorical form, it was found that the east side differed from the west side in the following particulars:

1. The timberline, by which term the *lower* limit of evergreen tree growth is here known, is found at a lower altitude, and the different zones of vegetation range lower.

2. The trees and tall shrubs are larger, taller, straighter, more thrifty and cleaner of limb.

3. A number of additional species of trees and shrubs are present occasionally on open slopes, on the west side rarely or never seen except in gulches. Among these are *Arbutus arizonica*, *Vitis arizonica*, *Rhamnus californica*, *Sambucus glauca*, *Robinia neo-mexicana*, *Parthenocissus quinquefolius*, *Rhus glabra*, *Prunus salicifolia acutifolia*.

4. An aspen grove is present on a somewhat open slope, at an elevation of only 7,400 feet (2,250 m.), under which twines not a little *Humulus lupulus*, and whose floor is covered with

Phacelia heterophylla and an abundance of *Scrophularia montana.* Such an occurrence would be next to impossible in a similar situation on the west side.

5. The underbrush (*Ceanothus fendleri*) is larger and more abundant.

6. The common brake (*Pteridium aquilinum pubescens*) is larger and prevalent under both pine forest and oak brush.

7. Herbaceous perennials are more abundant in species as well as individuals. Generally speaking they are larger in size, of more stout and luxuriant development in root, stem, and general form, the leaves are larger, broader, and more numerous, the bloom more profuse, and the fruiting more prolific.

8. Succulents and bulbous plants, such as *Sedum*, *Achroanthes montana*, and *Commelina dianthifolia*, are plants of the shallowest west side soil, and have little place here. To the same class belongs *Yucca macrocarpa*, a xerophyte of the most open west side slopes, rarely present on the east.

9. Annuals of the ephemeral type are practically absent.

10. The growing season is prolonged. This is evidenced both in later retention of green leaves, and the lengthening of the flowering season in perennials. Though this was not distinctly observed, it is probable that also the fruiting season is prolonged. Similarly, the pines retain their leaves longer.

11. The brake gives evidence of a distinct secondary growing season.

Adding only a few details by way of proof, it was observed that on October 5th many pine trees were still green, or yellow-green, while on the west side the forest was quite brown. The difference in time of leaf fall was estimated at a week or ten days. The brake, at the same date, was still to a large extent rusty green on the east side, but very brown and dead on the west. Commonly one or two feet tall on the west, it is usually two or three feet tall on the east side, and was seen to reach five feet at Miller's cabin (Spud Ranch). Here numerous young shoots begin to appear above the soil in September, and freshly developed full grown plants were seen in certain spots of rich soil in October. Very little or practically no new growth was seen on the west side.

What is the cause of these differences? No complete answer can be attempted at this time. To begin by elimination, it may be said that the two mountain sides are geologically of the same origin and chemically of the same general constitution. The entire mountain mass appears to be composed of granitic and gneissic rocks, and mica-schist. Its orographic genesis has given it a steep slope on the east, possibly due to an ancient fault scarp. On the west a more gentle one prevails, with a different lay of the rock, which may influence to some extent the amount and distribution of the soil and ground water. It is probable that the more or less horizontally cleft bed-rock and steep slope of that portion of the east side most particularly examined, give rise to rock talus, water conduits, and deep crevices filled with soil which may, in some cases undoubtedly do, account for the presence of some of the additional species, and other differences. Very little soil water comes to the surface on the west, where the rocks lie more flat and impervious, while a number of cool springs are found scattered over the east side, giving rise to characteristic spring societies. That these edaphic features are by no means accountable for the greater part of the floral contrast, however, is shown on certain portions of the west slope where escarpments, not unlike some smaller ones on the east, appear without changing the general aspect of the flora. While the east slope is steeper, it has, nevertheless, a deeper and more humous soil, in itself suggestive of better moisture conditions. This is possibly due primarily to certain physiographically determined climatic factors named below, and secondarily certainly to the reaction of the plant covering upon it, this in turn reacting upon the plants themselves.

Aspect, so far as identified with insolation, such a powerful factor on north and south slopes, likewise plays little part here. To be sure the sun rises from one to three hours earlier on the east, while copious dew is present on clear mornings, during which time there is probably very little moisture loss from either plants or soil. It also sets about three hours earlier, at about three to four o'clock P. M., during the growing season. This is not long after the daily heat maximum is reached, which is usually near one o'clock P. M., unless depressed to an extent of commonly 4°–6° F. by temporary noonday clouds, or depressed as well as shifted to the forenoon hours by clouds that last through the afternoon. If light is cumulative near the surface as well as heat, as is intimated in connection with Warming's

Greenland observation, * the daily light maximum may be reached about the same time. As the sun disappears temperature and moisture loss decline, and the day is considerably shortened. On the west, little dew is left when the sun rises, and the longer afternoon hours of sunshine contribute perhaps considerably toward a warmer and drier day. But the soil on both sides receives, daily, rays that are not far from the perpendicular in mid-summer, and the number of hours of sunshine are nearly the same. And, on the whole, the altitude is too high to put much emphasis, as must be done in the desert, upon the rigors of a long day as a limiting or directive factor of growth. On the contrary, if it is true that growth takes place mainly at night, as much of the inhibiting influence as may lie in temperature may be most active then, due to the low nocturnal temperatures.

In this connection may be given the results of comparative data that were gathered on the temperature of the air and spring water, and on precipitation, which it is hoped to give fully at another time. Indicating here only the general trend, it was found that the lowest nightly temperatures occurred on the west side. Here, at Manning's Camp, the mercury first touched the freezing point on October 6th, while at the eastern station, at Miller's Cabin, only 500 feet (150 m.) lower, and two miles distant, it had not fallen below 40° by the 24th. For a number of fair days in the middle of October the minima on the west ranged from 32° to 38° F., while the same days on the east showed 48 - 56° F. During the same period the maxima for the west side read from 57° to 67° F., while those on the east show a range of 56°-62°. The western station is therefore both slightly warmer in daytime and decidedly colder at night, and it is indicated that the two mountain sides possess a markedly different daily range of temperature.

While these data were taken at a date when the growing season was practically over, there is nothing to indicate that similar differences do not hold throughout the growing season. In fact, in the latter part of August, this being near the height of the vegetative season, a common maximum range at the eastern station was 15° or 16° F., while but a few days later a daily range of 33° was frequently reached on the west. On the desert

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*Drude, Pflanzengeog, p. 20, 1890.

below the range at this season is usually 40°–50°, and it therefore appears that the west side stands intermediate. The same difference was reflected in the spring water, which latter may be taken as slightly indicative of soil temperatures. That on the west showed a distinct daily fluctuation of one or two degrees, while in the slightly colder water on the east, no such change was measurable or even discernible. Nor did it show any tendency toward seasonal change, for it remained constant at 53° F. from August to the end of October. But while the east side shows highly equable and temperate conditions, and while the data may be slightly influenced by some degree of lateral protection of their stations, the opposite side does not show any such extremes as would seem decidedly harmful to the plant life of these mountains.

Neither can the contrast be explained on the ground of rainfall. The total precipitation at the western station for the rainy season beginning July 3rd and ending September 6th, 1909, was 15.95 inches. * From the eastern station records are available only from August 20th to the end of the season. For this period the rainfall was 2.80 inches (7 cm.), falling on six days, as against 4.75 inches (12 cm.) falling on 10 days at the western station. While the comparative data are too meagre for drawing conclusions, the figures, together with general weather observations made at the same time, point to a rainfall that is actually less on the east side. If this proves true, it will furnish an interesting local contradiction to Schimper's fundamental law of causal relationship between rainfall and vegetation, so strikingly shown in the Cascades and the Sierra Nevada.

A very marked difference appeared in the run-off. The east slope, being steeper, might be thought conducive to greater run-off. In fact, however, the heaviest showers produced no run-off whatever, except on trails, and not even a perceptible rise in the springs at Miller's Cabin occurred. Any rivulet gathering on a trail would be absorbed by the ground cover, usually before descending ten or twenty feet. Even where gullies were present, the pine needles and other material in their bottoms were not washed aside. The west side just after heavy showers presented quite different evidence to both eye and ear. The

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*Recorded by Messrs. Fenner and Gunter, and Miss O'Connell, from a gauge furnished by Professor Smith, of the Arizona Experiment Station.

chief canyons carried turbid and turbulent streams, and every gully and hillside depression, even quite near the summits, delivered its gushing rill. Ascending from Rincon Valley after a certain night shower, many a silver ribbon was seen from afar glistening in the morning sun as it meandered down over smoothly polished rock.

Thus, to use impersonation, while the east side practices an economy in water that is probably of very great importance, the west side spends it recklessly. But something else, not yet considered, is at the root of the problem, chief cause of the run-off as well as the difference in soil conditions and plant life. The most powerful factor in producing the contrast outlined is believed to be the wind. As the pine leaves fall in October, and spread a fresh brown carpet beneath each tree, all the tips of the leaves, after falling, point in an easterly direction, due to the wind. But this is true only on the west side near the main crest and on high ridges; on the east the fasicles lie in every direction. On the main crest here, as well as on several other high southwestern ranges visited, are many trees with the tops of their crowns bent eastward. Many others are distorted, and either partially or completely shorn of their crowns on the west side. Such evidence reveals the direction as well as the power of the wind factor. But these western gales, often blowing with great force, have been actually experienced a number of times while upon high divides during the autumn months. While occasionally coming from the east, as a trade wind should, it blows habitually sometimes constantly for several days, from the west. On the east slope no steady wind was experienced on any day, and it has left no impress. The usual atmospheric condition is calm, or, at most, periodic swirls or eddies produce a rustling of the leaves. It is like a sheltered haven, while overhead the clouds, if any, may sail eastward ceaselessly and rapidly, propelled by high wind. Even an east wind, being deflected by the steep slope, is little felt. On the main crest its crippling power may undoubtedly be exerted partly through mechanical stress, but on the west slope generally the chief factor must be its evaporating capacity, acting not only upon the soil, but as a most powerful draught upon the transpiration. Some of Livingston's atmometers, placed upon the two sides, would unquestionably develop marked differences in the evaporating power of the atmosphere.

As southern Arizona has two rainy seasons annually, so it has also two windy seasons, and these alternate with those. The wind is almost always at hand to intensify the drouth that a promised rain did not assuage. The Rincons form the first really high elevation in the trail of the trade-wind as it sweeps up from the Gulf of California. It has gathered heat from and lost moisture to thousands of square miles of desert on the way. Even on calmer days, it commonly plays in mid-day currents, like a blast from a furnace, from the heated plains below. In the afternoon it is usually replaced by a breeze which is markedly cooler, but which has probably lost little of its dessicating power. While rarely of high velocity, it quite regularly develops daily maxima and usually declines only on the approach of night. The west slope of the northern Rincons, being the one more particularly examined, lies back between projecting ridges, giving it a flue-like channel of ascent. Up over the entire, gentle western mountain side, from the desert foothills to the pine-clad crest, for several months of spring and autumn, almost daily plays, over every slope, this wind, and its power as a component of the plant environment can hardly be over-estimated.

Tucson, Arizona,
March 30, 1910.

TWO NEW ZEALAND BOTANICAL REPORTS.

BY S. B. PARISH.

Dr. Cockayne's recent reports on the botany of New Zealand, prepared in connection with the work of the Land Department, and published by the Colonial Government, while primarily of local value, contain much to interest and instruct students everywhere. Their value is enhanced by the very numerous photogravures, depicting the physiognomy and the ecological characteristics of that far-off land.

The first of these reports is concerned with the botany of Stewart Island,* which lies fifteen miles south of the South Island of New Zealand, and has an area of 425,390 acres. It is approximately as far south of the equator as Portland, Maine, or Portland, Oregon, is north of it, but its climate is totally different from that of either of those places. The rainfall of the island is heavy, the annual mean for the eight years preceding the date of the report being 63.64 inches. This precipitation is very evenly distributed throughout the year, the normal ranging from 3.37 inches to 6.47 inches per month, with an average of 246 rainy days in the year. Cloudy skies are also very frequent, even when no rain falls. There are no extremes of heat or cold; in winter only slight frosts occur at sea level,and in summer the mercury rarely reaches 70° F. The island is, for the most part, mountainous, culminating in Mount Anglem, 2,300 feet in height, while four other summits attain an altitude exceeding 2,000 feet. But even on these peaks snow lies but a short time, and the temperature probably never falls below 15° F. There is,therefore,little difference of season,either in respect to rainfall or temperature. This leads to some curious zonal commninglings, as where one sees growing together near the sea level, alpine plants and tender, cultivated Pelargoniums.

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*Report of a Botanical Survey of Stewart Island. By L. Cockayne, Ph. D., etc. Wellington 1909. Pp. 68. Photogravures 43. Map.

Very violent westerly gales are frequent, and it is this factor which is the controlling one in the ecological classification of the island flora, dividing it into "wind-tolerating" and "wind-avoiding" plants. The irregular contour of the land surface presents many different degrees of exposure to the force of the wind, or of protection from it, and the plant associations vary exactly in accordance therewith. The factor next in importance is soil moisture; but under the climatic conditions prevailing in Stewart Island, the amount of moisture retained in the soil depends largely on exposure, so that the character of the plant covering may be referred ultimately to surface configuration.

The influence of animals on the flora is so slight as to be negligable, nor has it been appreciably affected by the intrusion of man. Stewart Island, then, presents to the New Zealand naturalist a field of surpassing attractiveness; for whereas on the larger islands the flora, the fauna and the avifauna have been greatly modified, and in part exterminated, by human agencies, there is here preserved a bit of primeval nature,where yet exists the equilibrium attained by the long processes of ages.

While the island is largely forested there are but seven species of large trees, and two of these are exceedingly rare.

All of them are shallow rooted and some of them have very peculiar root systems. *Weinmannia racemosa*, for instance, begins life as a seedling on a fallen log, or a tree fern trunk, and as it grows sends branch-like roots to the ground, so that eventually the trunk, or trunks, for there are usually more than one, arise from the summit of an entangled mass of large roots.

Curiously enough the leaf epidermis of this tree has a distinctly xerophytic structure, hardly to be expected in a native of so moist a climate. But, in point of fact, there are among the plants of the islands those which possess the specialized anatomical structure, or such protective adaptations as a hardened or a reduced leaf surface, a tomentum or a varnish, which we are accustomed to associate with excessive aridity and insolation. Here they may rather be considered defenses against the evaporating effect of the winds.

The same force,· the wind, exerts a great modifying effect on the form and even on the vegetative character of some of the plants. Thus, *Leptospermum scoparium*, in sheltered situations, is an erect tree twenty feet high; exposed, it becomes absolutely prostrate,and forms a dense fan-shaped mat. The small ultimate branchlets, not over an inch and a quarter long, rise erect, and are so compacted as to present the appearance of a sward. They put down roots into the soil, and eventually the main trunk becomes entirely functionless. *Drachophyllum politum* has such a turf-like form, but it may also be a trailing shrub, with virgate stems eight or nine feet long; or it may be a dense, compact cushion, two or three feet in diameter.

Cushion plants are, indeed, a notable feature of the island flora. They are formed by densely tufted branches dividing into very short branchlets, whose extremities are covered with closely imbricated small leaves, all pressed together into a compact, hard mass. Such a plant is *Rasulia Goyeni*, which "looks more like a lump of coral than a living plant."

Another form of cushion plant is presented by some species of mosses and liverworts. These have the appearance of large moss-covered boulders, but are, in reality, water-logged masses of dead stems and roots, the extremities only being alive.

Sometimes the forest floor is carpeted with other Bryophytes abundantly intermingled with delicate ferns. The numerous species and the indescribable profusion of these Archegoniates is, indeed, everywhere strikingly evident. Of ferns there are enumerated 64 species, from the most delicate filmy species to those which are arborescent. The mosses and hepatics have not been worked out, but their number is very great.

The catalogue of the flora, which completes the report, shows the Filices to have the most species. Next comes the Compositæ with 57 species, the Cyperaceae with 48, the Gramineae with 36, and the Rubiaceae with 21, no other families having a large development. In reading the catalogue of the indigenous flora one encounters less than half a dozen familiar names, but in the part devoted to introduced plants there is found but one which does not have a place in the flora of the United States; an evidence of the great climatic adaptability of the common weeds; an adaptability to which they largely owe their cosmopolitan diffusion.

In addition to the detailed study of the ecological conditions and of the plant associations of the island flora, to which the report is mainly devoted, there are sections treating of the history of the island, its physiography, and the origin, development and relationships of the plant population. Agricultural possibilities are discussed, and are pronounced unfavorable, and it is recommended that the whole island be made a scenic reserve, for which purpose a considerable portion has already been set apart. An extensive bibliography completes the paper.

Dr. Cockayne's second report * is a contribution to the extensive literature relating to sand dunes. More than 300,000 acres in various parts of New Zealand are occupied by these dunes, mostly, as in other countries, on the sea coasts, but also in certain inland localities. Some of these hills are fixed, but others are, and most may become, traveling, and overwhelm fertile fields, forests and habitations. The destruction they have wrought in many countries is well known, so that, whereever they exist, they present a menacing problem of pressing importance.

The first part of the report is geological, and summarizes what is known of dune-building, the character and origin of the

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*Report on the Sand Dunes of New Zealand, By L. Cockayne, Ph. D., etc. Wellington, 1909. Pp. 30. Photogravures 35.

sands of which dunes are composed, and the various forms which they assume, and the application of these generalizations to the local conditions of New Zealand.

The botanical section begins with a consideration of the conditions determining the plant life of the local dunes. And here, again, wind-toleration is considered to be the prime factor. Then follow full descriptions of 13 native New Zealand plants that are either sand-binders or sand-collectors. The paper concludes with a detailed study of the dune-plant associations of western Wellington. The practical economic question, relating to the control and fixing of dunes,is reserved for a future report, the present paper being designed to supply the preliminary data necessary for an intelligent solution of the problem.

San Bernardino, Cal.

THE STARCH CONTENT OF LEAVES DROPPED IN AUTUMN.

BY L. L. HARTER.

It is generally believed that carbon assimilation and elaboration of plant foods in practically all deciduous trees, bushes, etc., cease at the approach of maturity of the leaf and the coming on of autumn. It is further supposed that the products of assimilation that are already in the leaves would be largely transported to other parts of the plant before frosts in the fall or before the leaves are dropped. If such is the case, the autumn leaves that fall to the ground after maturity would not contain much carbohydrate in the form of starch or sugars.

During the summer of 1909 the writer undertook to trace the changes taking place in the amount of starch formed in the leaves of *Liquidamber styraciflua* at different periods, and collected material for that purpose August 17, 1909, September 15, 1909, October 23, 1909, and October 28, 1909. Doubtless the leaves collected on the first two dates were in an active state of assimilation. The leaves collected on October 23 had taken on their autumn coloration and to all appearances contained little or no chlorophyll, while the material collected on October 28 was leaves freshly fallen and in most cases contained a noticeable amount of red pigment. The starch in the leaves collected at the different dates was determined quantitatively * and was found to be as follows: August 17, 10.91 per cent; September 15, 10.33 per cent; October 23, 11.47 per cent; and October 28, 10.79 per cent. The starch present was based on the dry weight of the material.

While there is no surprising variation in the starch content of the leaves of *Liquidamber styraciflua* collected on the different dates, the largest percentage was found in material procured October 23, the leaves collected at that time containing a conspicuous amount of red coloring matter. From October 23 to October 28 there was a reduction in the amount of starch present. The material collected at the latter date was picked up from the ground. An effort was made to obtain it soon after falling and containing as much green coloring matter as possible, though all the specimens contained more or less of the red pigment. It would seem from these results that so long as active assimilation takes place the starch content of the leaves of this plant varies but little. As autumn approaches and the red coloring matter develops the starch increases but again decreases before the leaves are dropped.

It is interesting to note in this connection the work of Overton † who found that anthocyanin could be developed by cultivating plants in sugar solutions. In the same series of experiments he showed that an increase of the red pigment in the cell was accompanied by an increase in the sugar content. Combes ‡ made a quantitative determination of the sugars and insoluble carbohydrates in the red autumn leaves of several different plants and compared them with the same substances in green leaves collected under similar conditions. He found some sugars and insoluble carbohydrates present in the red and green material of all specimens studied. In three out of five plants studied by him the amount of insoluble carbohydrates present was greater in the red than in the green leaves.

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*The method followed in determining quantitatively the amount of starch was as follows: The dry weight of the material was obtained by placing the leaves as soon as gathered, in a drying oven at a temperature of 100 degrees to 110 degrees C. The chlorophyll and sugars present were removed by washing thoroughly in 60 per cent alcohol. The starch, or substances capable of reducing copper in Fehling's solution were hydrolized by boiling the material in a weak solution of hydrochloric acid. After neutralizing the acid with sodium hydrate the solution was clarified with lead acetate. The lead acetate was removed by precipitating with sodium carbonate. A definite quantity of this solution was added to Fehling's solution and the whole boiled for two minutes. From the amount of copper reduced, the per cent of starch per dry weight of leaf material was calculated.

†Overton, E. Beobachtungen und Versuche uber das auftreten von rothem Zellsaft bei Pflanzen. Jahrb. f. Wissen. Bot. 33: 171. 1898.

‡Combes, R. Rapports entre les composes hydrocarbones et la formation de l'anthocyane. Ann. Sci. Nat. Bot., 9 ser. 9 (1909). No. 4-5, pp. 275-303.

Since so much starch was found in the fallen leaves of *Liquidamber styraciflua* similar material[*] was collected from several other plants and the starch determined as above. Before the starch was determined quantitatively many leaves were sectioned and tested with iodine for starch. In most cases there was a comparatively large amount of starch present as shown by this test.

The amount of substances present in the leaves capable of reducing copper in Fehling's solution as determined by the above method are shown in the following table:

Liquidamber styraciflua	10.79 %
Ginkgo biloba	6.32%
Platanus orientalis	11.84%
Platanus occidentalis	9.89%
Styrax americana	5.91%
Magnolia obovata	7.19%
Quercus pedunculata	14.54%
Elaeagnus umbellata	10.24%

It would not be possible without the use of special methods of chemical analysis to say what substances besides starch are present in the material, that will reduce the copper in Fehling's solution. There are other carbohydrates, such as pentosans, which are hydrolized by boiling in hydrochloric acid and which reduce copper, that will be included along with starch. The sugars, if any were present, were removed by washing the material for several hours in alcohol and water.

The above table shows that all plants studied contain an appreciable amount of insoluble carbohydrates but with considerable variation between the different plants. Such variations are not surprising. It is likely that the same plants would show as great a variation if the material was collected at a time when active assimilation was taking place. Meyer[†] found that under normal conditions plants of different families varied greatly in the amount of starch produced, and in some cases none was found, as for example, in many Liliaceae, Amaryllidaceae, and Iridaceae. Combes * determined quantitatively the insoluble carbohydrates and also sugars in the leaves of plants collected after autumnal frosts. The leaves were picked from the plant and not taken from the ground. The amount of insoluble carbohydrates present in the green material so collected by him was as follows: *Rosa canina*, 9.72%; *Mahonia aquilifolium*, 2.38%; *Sorbus latifolia*, 11.99%.

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[*] All material for these determinations was collected about 1 p. m. on a clear day. Care was exercised to obtain specimens containing a large amount of chlorophyll but in practically all cases some autumnal coloration was developed.

[†] Meyer, A. Ueber die Assimilationsproducte der Laubblatter angiospermer Pflanzen. Bot. Zeit. 43: 417. 1885.

It is impossible to explain beyond question what the chemical changes are that take place which prevent the leaves from transporting their food materials to other parts of the plant before the leaves are dropped. Such an explanation must therefore necessarily be largely theoretical.

It is a well known fact that before starch can be translocated it must be converted into a soluble carbohydrate. Such a change is brought about by diastatic enzymes. Anything, therefore which would destroy diastase or inhibit its activity would also interfere with the translocation of starch. While the writer has never followed out the chemical changes that take place in maturing leaves in autumn, except the formation of carbohydrates in *Liquidamber styraciflua* as mentioned, it is possible that diastase is the first of the enzymes to suffer in the destructive processes which take place in the cells. Woods † showed that oxydizing enzymes under certain conditions retarded or weakened the action of the translocation diastase. He also calls attention to the fact that the coming on of cool weather in autumn and the approach of maturity in the leaf stimulate the production of oxidizing ferments. ‡ It is possible, therefore, that diastase, either as the result of the inhibitory action of the oxidizing enzymes or its complete destruction by some other means in the leaves of the plants here studied, has lost its power of converting starch into sugar before the chlorophyll in the leaves ceases carbon assimilation. Under such conditions the chlorophyll might continue to manufacture starch which because of the inactivity of the translocation diastase, must necessarily remain in the leaves of the plant, and if continued for a number of days might accumulate in considerable amount.

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*l. c.

†Woods, A. F. Inhibiting action of Oxidase upon Diastase, Science, N.S., 11: 17. 1900.

‡Woods, A. F. Autumnal Coloration of Foliage. Enclyclopedia of Horticulture.

BOOKS AND CURRENT LITERATURE.

Whitford has contributed to the *Philippine Journal of Science* a paper entitled "The Composition and Volume of the Dipterocarp Forests of the Philippines." He has made valuation surveys in six of the largest islands and states that of the 40,000 square miles of virgin forest in the archipelago 30,000 are made up predominantly of members of the Dipterocarpaceae, which occur in stands simple enough to admit of their being utilized by modern steam logging methods, and comprise both hard and soft woods capable of a diversity of uses.

Whitford's earlier work on the forests of the Lamao Reserve in Luzon showed them to have a complex composition in which the Dipterocarps formed 30% to 40%. In those surveys all trees over 4 m. in height were enumerated, while in his more recent work only trees of merchantable size—over 30 cm. in trunk diameter—have been taken into account. In one of the Lamao tracts the merchantable trees were 71% of the total enumeration, and of them 50% were Dipterocarps. The nine sets of data given in the present paper show the Dipterocarps ranging from 33% to 89% of the stand and from 46% to 95% of the volume. Some grouping of the 35 Philippine species of this family is found to be predominant "in all classes of habitats from sea level to an altitude of approximately 900 metres." The author states that the forests of Bataan are subjected to a pronounced dry season and those of the delta plain of Mindoro are periodically flooded, in each of which cases the forest is less in volume and more complex in composition than in such locations as the plains of Negros, where "it is believed that a combination of edaphic, climatic and biotic factors has reached the optimum necessary to the establishment of the most successful growth in the Philippines." All situations which are unfavorable through the character of the soil, steepness of slope, etc., are poorer in Dipterocarps, and such situations as the Negros plains much richer in them. The author therefore regards the forests with the highest percentages of Dipterocarps as the most successful in the islands, and those which are poorer in them as some stage in succession toward that type.

Whitford's studies are the first of their kind and extent which have been carried on in tropical forests and they indicate a very much simpler make-up than has been reported for forests in other parts of the torrid zone. Warming states that in Lagoa Santa it was difficult for him to find two trees of the same species anywhere near each other and reports a total tree flora of 380 species; Whitford states that the Lamao Reserve has 548 tree species at the same time that the Dipterocarps are predominant. This means, of course, that the floristic complexity of the forests is given them by the smaller trees between the standard of 4 m. in height and that of 30 cm. in diameter. It is quite probable that many travelers in tropical forests have been given the impression of their complexity by this small-sized and more accessible element. Another suggestive feature of the paper is the showing that forests in the most favorable situations are "the most successful" and have the simplest make-up. That they are the most successful—which is to say that the component trees are greatest in size and volume—is to be expected, but that they should be simplest in composition quite reverses the long accepted view that it is the ease and favorableness of the environmental conditions which has brought about the rich make-up of tropical forests.

Other papers are promised by Whitford, which will probably, like the present one, combine great interest for the student of vegetation and for the commercial explorer. In spite of the originality and importance of his work, and the fact that he has taken more notice of physiographic and soil conditions than the classic authorities on the tropics did, there is no good reason for allowing his facts regarding a relatively small body of insular forest to compel a re-casting of our conceptions of the great continental bodies of tropical forest.

Dr. B. E. Fernow, Dean of the Faculty of Forestry of the University of Toronto, has produced a manual on "The care of Trees" (H. Holt & Co., $2) which will be found useful by every one concerned with the care of trees in lawns, streets, and parks. The information given for the diagnosis of diseases and defective growth, directions for planting, fertilizing, pruning, as well as for the surgery of damaged trunks and branches and control of parasites, will be gratefully received not only by the amateur with a half-dozen trees under his care, but also by the superintendent of a great city park. Some attention is paid to the handling of trees and shrubs as units in landscape art, in connection with which are also some lists of species desirablefor special purposes.

NOTES AND COMMENT.

The last two lines of the second paragraph of comment upon the climate of the southwest on page 102 of the PLANT WORLD for April, should read, "North America, and this region has two rainy seasons. Over much of this area the precipitation is greater in winter than in summer." To this correction may be added the further information that most localities above 3,500 or 4,000 feet altitude in this region receive more rainfall in winter than in summer, and that the total for the winter may reach as much as twenty or twenty-five inches. Prof. Ellsworth Huntington, of the Department of Geography of Yale University, has recently traversed much of the southwestern desert for the purpose of making a study of the climate, especially with respect to secular variations within recent geologic time, and his results promise to be of interest to all botanists.

The extent to which institutions having for their primary object the accumulation and dissemination of practical knowledge in agriculture and horticulture are becoming centers of research is illustrated by various recent publications. Reference to the subjects discussed in the Yearbook of the United States Department of Agriculture for 1909, for example, shows very impressively the wide range and the increasingly scientific character of the work. Though professedly, and actually, conducted on a thoroughly practical basis, the matters under consideration and the men detailed to their investigation make it plain that a large part of the work is of lasting value from a scientific point of view. The control and eradication of diseases of both plants and animals, the development of dry land agriculture,the introduction and establishment of useful plants, the standardization of cotton, and improvement of grains, the work of the great bureaus of chemistry, soils, and others, the biological survey, and various special investigations make up a part, and only a part, of the yearly program of this great institution.

By a cooperative undertaking between the United States Department of Agriculture and the University of Wisconsin, the Forest Products Laboratory at Madison, Wisconsin, to be opened June 4, has been established to aid, through experiments and demonstrations, the lessening of waste in the manufacture and use of wood. The state has erected for the purpose a new building at the university, and will furnish also the light, heat, and power. The Department of Agriculture has supplied the equipment and apparatus and will maintain the force of thirty-five or forty persons required to carry on the work. Through this arrangement, the United States has secured perhaps the largest and best equipped wood testing laboratory in the world.

The laboratory will be prepared to make tests on the strength and other properties of wood, to investigate the processes of treating timber to prevent destruction by decay and other causes, to study the saving of wood refuse by distillation processes, to examine the fiber of various woods for paper and other purposes, and to determine the influence of the microscopic structure of wood on its characteristics and properties. Facilities are at hand, in fact, for almost any kind of test on wood that practical conditions may require.

The circular sent out by the United States Forester, while thus emphasizing the practical importance of the work to be undertaken, makes it apparent that the investigations planned will also be of great scientific value.

The University of Arizona Agricultural Experiment Station has issued a useful bulletin on "Drought-Resistant Plants for the Arid Southwest," by Professor J. J. Thornber. The amount of first hand information contained in this paper, which appears under the modest title of "Timely Hints for Farmers," and its importance for the whole arid and semi-arid region included in its scope is such as to call for more extended notice than can be given it in the present issue of the PLANT WORLD. Arrangements will accordingly be made for its reproduction, in whole or in part, in a later number.

In nowise inconsistent with the thought expressed in the preceding notices is a timely word from the preface of Dr. Jepson's recently published "Trees of California." The author "cherishes the hope that these pages may be an inspiration to some who have opportunity to take up special studies of our trees for the sake of the intellectual pleasure and cultivation to be derived from such an avocation * * * In spite of our worship of the practical it is being more widely recognized that the cultivated man with keen intelligence and a broad, liberal outlook is getting more out of life and is really more practical, after all, than the so-called practical man who has narrowed his interests to those which concern his immediate personal needs, who is not stirred by the lure of the unknown, and who has locked his door against the ideals and imaginations of humanity."

It is a satisfaction to note that "it has not been the aim to popularize" the book. "A thoroughly popularized botany book usually contains very little botany. Such excessively diluted pabulum may momentarily tickle some palate, but it can afford no proper and sustaining food to a man or woman who is really and truly alive."

Moving on serenely amongst the pitfalls of the English language, and none the less contributing data of both interest and value, a German seed firm sets forth the useful characteristics of the Austrian pine as follows: "This pine wants more warmth in despite of its very modest pretensions to dampness of air and soil, but it may resist to severe winters, if there are warm summers of rather longer duration at its disposal.

"It is especially modest in its pretensions as to the nourishing qualities of the soil. The minimum nutrient offered by the bare rock, boulder or poor sand, suffices for its living. The tree adapts itself very well to shallow soils with flattened taproot and superficial, far-reaching lateral roots, in the deeper soil it is seeking for its nourishment, however, with the vertically growing roots in a more limited space. *Its pretensions to the dampness of soil are very modest. It subsists on the most barren* and dry places, *like burnt out rocks.* It is the same case with the dampness of the air. The dryest air as prevailing in its southern quarters does no harm and the P. resist equally well to drying-up winds. *Although the P. is asking for so small offerings of the soil, it gives on the other hand rich gifts in return. The waste leaves are the most valuable material for the formation of humus* and the plant is thus returning a rather large quantity of the nutrient materials taken out from the soil. The tree is protecting at the same time its ground by a thorough and enduring vegetation against the noxious influences of wind and sun."

How a pupil of Agassiz relieved himself under the stress of the once prevailing hypothesis of special creation is told by N. S. Shaler in his autobiography. "He was puzzled by the transitional varieties between many of the species of molluscs he was studying, especially those occurring among the fresh water gasterpods. On one occasion I saw him throw one of these vexatious shapes on the floor, after he had studied it a long time, put his heel upon it and grind it to powder, remarking, 'that's the proper way to serve a damned transitional form.' "

At about the time of writing this paragraph the International Congress of Botany at Brussels, May 14-22, 1910, should receive the reports and propositions of the Commission of Phytogeographical Nomenclature elected at the Vienna Congress in 1905.

This commission consists of Briquet, Adamovic (Vienna), Beck von Mannagetta (Prague), Drude (Dresden), Engler (Berlin), Flahault (Montpellier), Harshberger (Philadelphia), Schroeter (Zurich), W. G. Smith (Edinburgh), Warburg (Berlin), Warming (Copenhagen), and, as was to be expected, has prepared a comprehensive and clearly stated report, which, if adopted, should go far to bring about a more settled and satisfactory state of things.

Certain fundamental principles are enunciated which appear well nigh self-evident. Two or three of these are the following:

(1) Those who work at the same science ought to try to understand one another; pedantic pretensions to erudition are useless or dangerous to science.

(2) It is necessary to bring scientific language as closely as possible into line with ordinary language. This is the surest means of avoiding the alienation from the study of science of those who are drawn towards it and who can help in its progress.

(3) While leaving everyone full liberty to express himself as he pleases,it seems necessary to insist on one point—The condition essential to the avoidance of ambiguity is that every au-

thor should enunciate clearly the exact meaning he gives to his terminology.

The nomenclature of geographical and topographical units and also of biological units is considered, the views of various well known botanists are reported at length, and a certain number of definite propositions are presented to the Congress. The citation of works of upwards of 160 different authors, "which contain an expression of new points of view in regard to phytogeographical methods," adds to the value of the report and shows very impressively something of the remarkable development of the branch of science for which it is sought to open the way to the attainment of a usable and stable nomenclature.

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THE PLANT WORLD

A MAGAZINE OF GENERAL BOTANY

JULY, 1910

ROCKY MOUNTAIN RAMBLES.*

BY L. H. PAMMEL.

Those who have done botanical collecting in the Mississippi Valley, in a state like Iowa, have found that the floristic features of the adjoining states do not differ essentially except in some local particulars. There are no violent topographic changes. The streams have carved their way through the different geologic formations, sometimes with a narrow flood plain, as the Des Moines, or the flood plain is more ancient, as the adjacent Skunk, which is but sixteen miles east from Boone. One can only observe in a general way that some species are north bound, as the sycamore (*Platanus occidentalis*), which reaches its northern limit along the skunk near Ames, although another southern species, the buckeye (*Aesculus glabra*), does not occur on this older stream in this vicinity, though abundant along the Des Moines a little north of Boone, and again along the Iowa to Hardin county, a little north of Marshalltown, and along with it the cherry birch. Of the south bound species, two birches, the paper birch (*Betula papyrifera*) and the cherry birch, are remarkable, the former occurring along the Mississippi and its tributaries in eastern Iowa south along that stream to a little north of Clinton.

The plants of the small prairie-like openings in Wisconsin where my early botanical collecting was done, do not differ essentially from those found on the prairies of Iowa. The same Gentians, Liatris, Spiranthes, *Aster multiflorus* and *A. laevis* occur along the roadsides there, as in Iowa. The meadow sunflower (*Helianthus grosseserratus*) is abundant in the swales, as in Iowa, except that it is more abundant in the prairie region than in a country broken up with timber.

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If we go northward through the prairie region of Minnesota into Manitoba, the same types of plants occur. Near Winnipeg the *Aster multiflorus*, *A. laevis*, *Solidago rigida*, *S. missouriensis*, *Psoralea argophylla*, *P. esculenta*, *Silphium laciniatum* are much the same as on our Iowa prairies. The grasses like *Panicum virgatum*, *Andropogon provincialis*, *A. scoparius* are common and much like our Iowa plants. The *Helianthus Maximiliani*, common in northwestern Iowa, extending eastward to the Mississippi in northern Iowa and southern Minnesota, is, however, not common along the Mississippi in Iowa or southeastern Minnesota. It is a much more common species in Manitoba than the *H. grosseserratus*. It, like all other plants, is smaller in Manitoba than in Iowa. As we go west from central Iowa the prairie country is broken up by numerous small ponds contain-

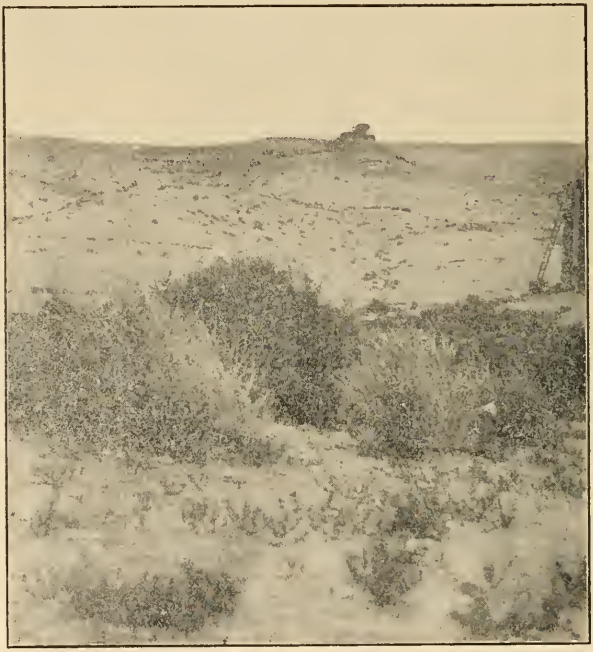

Fig. 1. Xerophytic vegetation. *Tetradymia Nuttallii*, a spinescent composite shrub, and greasewood, Green River County, Wyoming.

ing the usual aquatic plants, like the *Scirpus validus*, *Phragmites communis*, *Typha latifolia*, *Phalaris arundinacea*, and occasionally the *Zizania aquatica*. These same species are quite as common in the Missouri Valley as in the Mississippi, and also in the Rockies, except the wild rice. There is also an additional species of cat-tail in the Rocky Mountain region near Denver, the *Typha angustifolia*.

The trees of the Des Moines basin are generally similar in species to those found along the Mississippi in the same latitude, but there are not so many. The Des Moines basin marks the western limit of the hard maple (*Acer nigrum*) in Iowa. Of the deciduous trees, the oaks are much the same as in Wisconsin and Minnesota. The *Quercus rubra* is much more common than the white oak, while the bur oak seems to have been able to occupy virgin soil in the region, and is the only species reaching northwest in Iowa. Old gnarled trees between

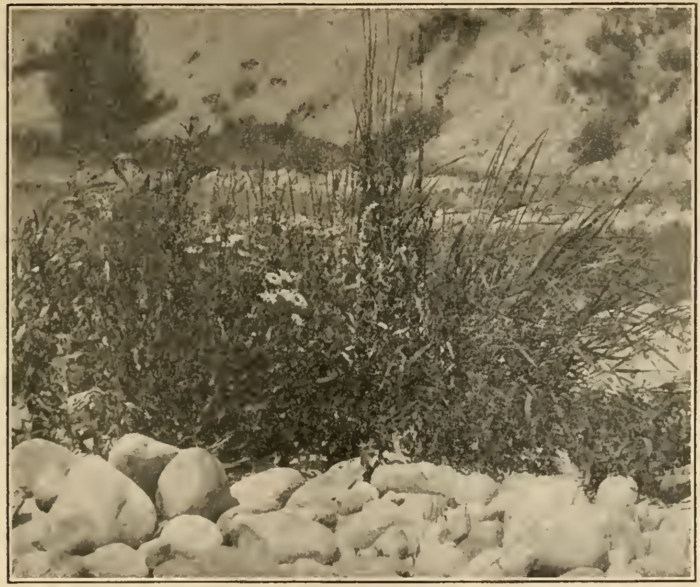

Fig. 2. Vegetation on the banks of Black's Fork in the Uintah Mountains at an altitude of 9200 feet. The herbaceous plants are *Erigeron glabellus*, Canadian Peppermit (*Mentha canadensis*), and False Quack (*Agropyron pseudorepens*).

200 and 300 years were not uncommon in the flood plains of many of our streams. West of the Des Moines basin the country is more undulating and the Missouri loess becomes more evident. The flora, too, changes. It is characterized by the invasion of some western species like *Aplopappus spinulosus*, *Euphorbia marginata*, *Gaura coccinea;* in northwestern Iowa the *Mentzelia ornata*, *Cirsium canescens*. The most conspicuous plant, however, is the yucca (*Yucca glauca*) which becomes more common westward, especially as we reach the Rocky mountains. In Iowa it usually blooms in June or early in July, but it is in its prime in the foothills of the Rockies the latter part of June and early in July. The pendant more or less bell-shaped yellowish-white flowers hang in ample racemes and make a fine display in the otherwise monotonous landscape. The species is abundant about Manitou and Colorado Springs and on the west slope near

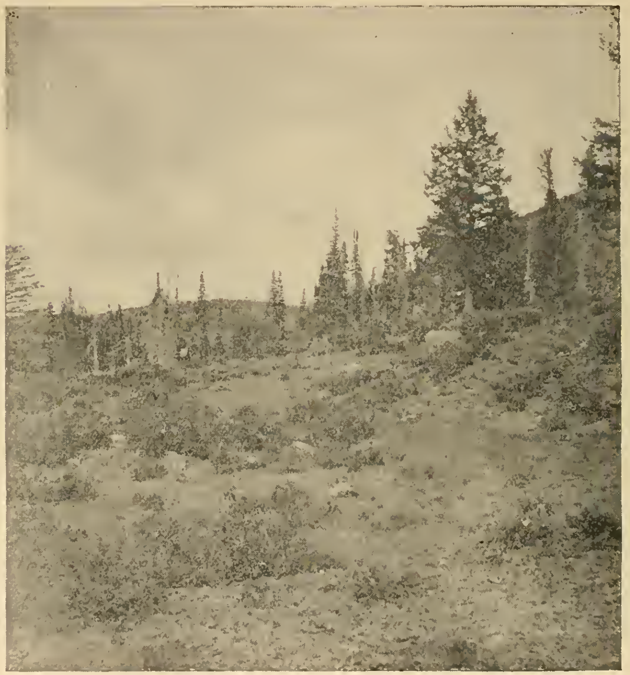

Fig. 3. Lodge Pole Pine (*Pinus Murrayana*) and Subalpine fir below timber line, near Petersen, Utah. Elevation 9000 feet.

Placerville in the San Miguel range. The plains east abound with the prickly poppy (*Argemone intermedia*) which occupies in places many acres and is a frequent plant in the Salt Lake basin in Utah.

The genus *Oenothera* is abundantly represented on the plains. The large-rooted morning glory (*Ipomoea leptophylla*) occupies open places about Denver and eastward to Nebraska, while the ungrazed areas along the railway are lined with the white-flowered *Oenothera pinnatifida*. The white-flowered *Oenothera coronopifolia* is conspicuous on the plains and in the foothills. *Oenothera albicaulis* is common not only in the Colorado Rockies but also in the Wasatch mountains and at lower altitudes in the Uintah Mountains. The *Oenothera caespitosa* is common everywhere on dry hills; the large white or rose-colored flowers are conspicuous, and other acaulescent species also occur in the region on shaly rock. The *Oenothera missouriensis* with large yellow flowers is more common east of the divide on the plains adjacent

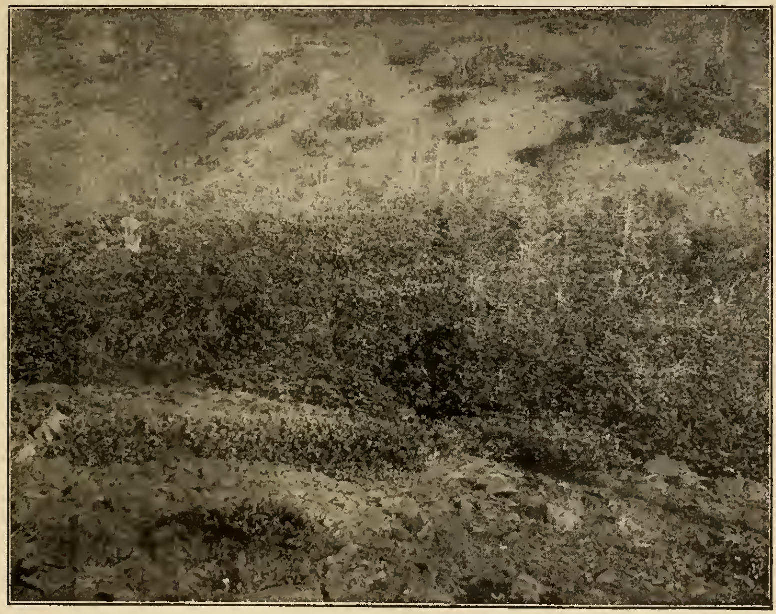

Fig. 4. Dwarf Engelmann Spruce (*Picea Engelmannii*) at an altitude of 12500 feet in the Uintah Mountains, Utah.

to the Rockies or up in the foothills. Perhaps none of the plants is more interesting in the Rocky Mountains than the Rocky Mountain columbine (*Aquilegia caerulea*), which was first described by Edwin James from material found in the Rockies in the vicinity of Long's Peak. This beautiful and showy plant is quite as common on the eastern slope of the Rockies as it is on the western slope. Early in June it may be obtained in abundance along any of the mountain streams at altitudes above 7,000 feet and thence up to timber line. The writer found it quite as abundant in the San Miguel Mountains as in the Mount Ouray region or in the Medicine Bow Mountains. It is also common in the Uintah range. A high alpine species, *A. saximontana*, is found in great abundance above the timber line on Mount Ouray. It appears in great bunches from among the rocks. The leaves are smaller and twice ternate, the smaller flowers have bluish

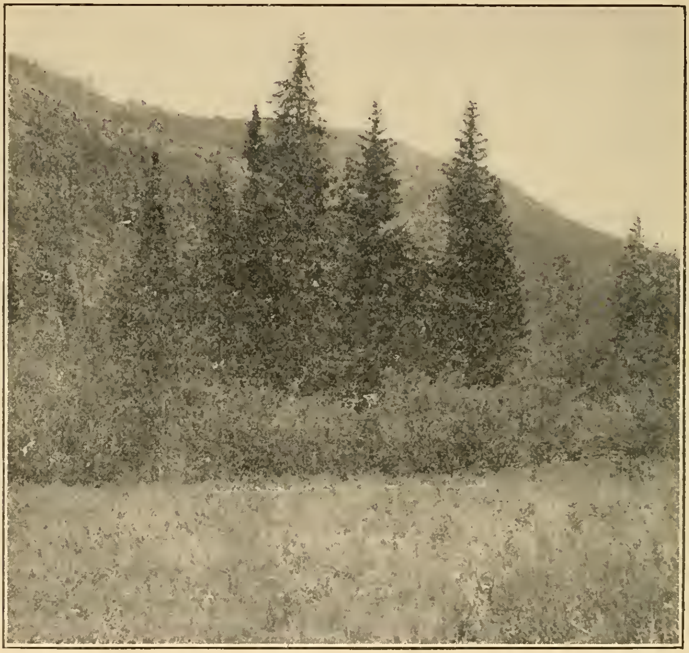

Fig. 5. Near the head waters of the Weber River, Uintah Mountains, Utah. The mountainous region with burned over lodge pole pines, in the foreground a willow swamp consisting of *Salix glaucops S. irrorata and S. chlorophylla* and a group of Engelmann Spruce (*Picea Engelmannii*) at 9000 feet.

sepals and yellow petals. Occasionally one finds the *A. elegantula* of Green in the Marshall Pass country though reported from quite a number of other points in Colorado by Rydberg. The *Aquilegia brevistyla* is a more prevailing type at higher altitudes in the Wasatch Mountains, and one form or another occurs in the north to the Canadian Rockies.

Orchids are not common in the Rockies. Outside of the species of *Habenaria*, there are comparatively few genera or species anywhere. The most common species in Colorado and northward and the one most frequently met with is the *H. hyperborea*, the *H. dilatata* is less frequent, while the *H. unalaschensis* is found in the Uintah and Wasatch Mountains northward into British Columbia. The *Epipactis gigantea* occurring at lower altitudes frequently along irrigation ditches is not common in Colorado nor Utah, but it occurs northward to British Columbia. The Goodyera or rattlesnake plantain (*G. Menziesii*) is not common in the southern ranges, and I only observed it in British Columbia where it is not infrequent in the spruce, pine. and fir woods. Attention might be called in this connection to the occurrence of yellow lady's slipper (*Cypripedium parviflorum*) which the writer has seen in the mountains in the vicinity of Palmer Lake and Manitou. The plant was perhaps never as abundant, nor any of the other species, as formerly in Iowa, Wisconsin, and Minnesota. Dr. Aven Nelson records another species *C. Knightae* for the Medicine Bow Mountains.

Rydberg, in his Flora of Colorado ,lists twenty-three species of orchids native to that state. Dr. Nelson lists only nineteen for the Central Rocky Mountain states. After the most thorough collecting by Prof. Crandall and other Colorado botanists, it is doubtful whether many other species would be added to this list. At least the ordinary collector will not see anywhere near this number.

One of the most interesting plants on the plains adjacent to the Rockies is the wild pumpkin or gourd (*Cucurbita foetidissima*) which is found in abundance in the vicinity of Colorado Springs, Pueblo and in the Arkansas Valley to Canyon City, and is not infrequent on the plains of western Nebraska. Though its range is given as west to California, it certainly is not common along any of the ordinary routes of travel on the west slope of the Rockies. This striking plant produces a large perennial root. It seems to defy any amount of dry weather. One is interested also in the *Cactaceae* found in the eastern plains. The Opuntias like *O. Rafinesquii* are common on the plains of Denver, and the same is true of the *O. missouriensis* and the prickly red-flowered *O. rhodantha*. One is interested in seeing for the first time as one passes along the line of the D. & R. G. R.R., in the vicinity of Pueblo, the small tree-like *O. arborescens*.

The conifers of the Rocky Mountains and the Pacific Coast are the most characteristic features of the region. The species are fairly numerous. In the lower altitudes on the east slope of the Rockies the bull pine (*Pinus ponderosa*) is abundant but occurring more or less in scattered groves and here and there in canyons and draws; or on the slopes of the mountains is the *Juniperus scopulorum*),while in the northern regions in Canada is the red cedar *J. virginiana*). On the west slope of the mountains is the western red cedar (*J. occidentalis*) and the variety *monosperma*); on the south side of the Uintah Mountains it forms a well marked zone, especially abundant on the limestone shale. The undergrowth here consists almost entirely of a few vernal blooming plants and a few hardy shrubs like *Rhus canadensis* var. *trilobata* and in the canyons the *Amelanchier alnifolia*.

The zonal distribution of these conifers is certainly well marked in many ranges. The Douglass fir (*Pseudotsuga Douglasii*) is common everywhere in the canyons above 6,000–7,000 feet, in the front Rockies, in the San Miguel region as well as in the Uintah and Bitter Root Mountains. In the latter mountains it hardly extends beyond 8,000 feet, while in the Wasatch Mountains I have found it close to 10,000 feet. In Colorado the zonal distribution is something like this, first the *Pinus ponderosa* and *Juniperus scopulorum*, then the Douglass fir and black fir (*Abies concolor*), sometimes associated with the *A. lasiocarpa*. The Colorado blue spruce (*Picea Parryana*) extends much lower down than the Douglas fir and in the Uintah Mountains occurs in marshes and swamps from 6,500 feet to 8,500 feet, but of course at a much lower altitude on the Pacific Coast and in Montana, in southern Colorado followed by the Pinon pine (*Pinus edulis*) then *Pinus ponderosa* at an altitude of 8,000 feet, where it occupies the mesas and slopes and beyond the lodge pole pine (*Pinus Murrayana*), Engelmann spruce (*Picea Engelmanii*), the *Abies lasiocarpa* also associated with the latter. There are two additional pines in the Rockies that are similar in aspect, one the limber pine (*Pinus flexilis*) which is common at higher altitudes where it often gets the full sweep of the wind. The species is common in Colorado in the Uintah Mountains, northward and westward. Its altitudinal range varies from 8,000 to 11,500 feet in Colorado, and at lower altitudes in Montana. The white bark pine (*P. albicaulis*) is less widely distributed but is not uncommon in northwestern Wyoming, Bitter Root Mountains, with a lower and more rounded head; at higher altitudes it is a dwarf tree.

In the Bitter Root Mountains of Montana, the adjacent regions of Idaho, and in northern Washington, the *P. ponderosa* occupies the ridges and slopes along streams at a much lower altitude than in southwestern Colorado where it is found at about 8,000 feet. The Douglass fir usually follows, and in the Wasatch Mountains it may reach 10,000 feet. The species is found near tide level in Washington and Oregon. It is abundant in the Cascades, and here, as elsewhere, it has been found that this species succeeds best on the well drained soils. The thick bark of *Pinus ponderosa* and *Pseudotsuga* protects these species from fire.

Trees of the *Abies concolor* are abundant in the canyons of the Wasatch Mountains. It is common on the more moist but well drained slopes in the Weber canyon, and the Logan Mountains. The lower regions are often covered with white oak (*Quercus undulata*) which in the Wasatch and the Uintah mountains covers thousands of acres. The trees are seldom more than 4–6 inches in diameter and 15–25 feet high. In the Wasatch mountains as well as in the Bitter Root Mountains the *Ceanothus velutinus is common;* the small openings contain a great deal of *Balsamorrhiza sagittifolia* and in places where the snow lies longer the *Weyethia amplexicaulis* is abundant.

(Continued in August Number.)

THE PREVALENCE OF CERTAIN PARASITIC AND SAPROPHYTIC FUNGI IN ORCHARDS, AS DETERMINED BY PLATE CULTURES.

BY FREDERICK ADOLPH WOLF.

INTRODUCTION.

Chiefly because of the numerous colonies which appeared in glucose agar exposures in a grove near the Agricultural Hall, Lincoln, Nebraska, the suggestion was presented to try similar exposures in the orchard. It was then a question as to whether the same forms of fungi were present in both places. As a result of this exposure, the idea was suggested that it might be of interest to make a series of exposures in the orchard at definite intervals during the year, beginning with September and continuing throughout the following winter and spring.

While it is known what fungi are common upon the trunk, twigs, leaves and fruit of orchard trees during the summer season, or growing period, yet little or nothing has been done toward the determination of what is present during the winter season, the dormant period of the tree's life. This is not without a reason, however. It may be due, in part, to the fact that generally no new infection occurs during the winter period. It might naturally be expected, too, that while the tree is dormant the fungi which attack it would be dormant. This is true only in part. While there is little or no vegetative growth during the winter, yet some forms develop or at least mature their perfect fruits at this time.

The plant pathologist recognizes that at particular periods of the year, certain parasitic fungi are abundant. He knows, too, that where sugary compounds, such as fruit, bread, jelly, preserves, etc., are kept, certain cosmopolitan saprophytic species abound. Then, in orchards, one might expect to find parasitic forms numerous only at a particular time, while saprophytic species might abound at any time.

Most of the work of determining the presence of living organisms in a certain locality or in a certain substratum has been bacteriological. One investigator, K. Saito,* of the Imperial University of Tokyo, determined the number of fungus spores in the air. At various times from May 1, 1901, to May 1, 1903, he placed petri-dishes with gelatine in the garden, hospital, and laboratory. He made counts of the number of fungi found. Temperature, rain, and wind had a very great influence upon the number of spores present in any locality, but there was little or no difference at the same time in the different locations. The most abundant were *Cladosporium herbarum*, *Penicillium glaucum* and *Epicoccum purpurascens*; next came *Aspergillus glaucus*, *Catenularia fuligena*, *Mucor racemosus*, *Rhizopus nigricans*, *Macrosporium cladosporoides*, and *Monilia* sp.

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*Saito: Journal of Science College, Tokyo, 18:1-53.

In the summer months, *Botrytis cinerea* and *Verticillium glaucum* were the most abundant in the atmosphere of the garden, and in the winter, *Heterobotrys* sp. and *Fusarium roseum*.

This paper is concerned only with those forms which are found in orchards. The aim of the work was to determine what parasitic or saprophytic fungi were present at different periods of the year, by exposing petri-dishes containing glucose agar.

METHOD.

The orchard which was made the basis for the work was in Field 6, at the Nebraska State Farm. Three stations were chosen at which to make the exposures each time. By securing uniformity of location for each exposure, it was hoped to get more uniformity in results. One station was chosen in a portion of the orchard where the ground cover was clover and alfalfa, another in which absolutely clean cultivation, nothing being permitted to grow on the ground, was practiced, and another in which the cover was millet stubble.

In every case, the medium used in the trap cultures has been glucose agar, made by adding glucose enough to equal 3% of the weight of the plain agar with the reaction plus 10. Special experiments have involved the use of other media. This was done partly in the hope of determining more of the habits of the various fungi and partly to aid in determining the species. It was not hoped by this means alone to ascertain definitely the species, yet mycological literature is full of descriptions of fungi, in which brief notes upon a single colony on a named substratum are the only bases of identification. In these a spore measurement is seldom found.

It is needless to say that a valuable classification of such molds as Aspergillus and Penicillium must be based upon ascus formation. Dr. Fr. Dierck* has said "Moulds vary immensely according to the circumstances under which they are observed. In Penicillium, for instance, the only hope of stable identification is in cultures for several generations under rigorously uniform conditions." Since it is well known that many forms do not produce their perfect fruits on glucose agar, and as it is not within the scope of this article to develop methods of discovering fruit formation, interesting as it may be, where the species can not be readily determined, no species name will be given.

Almost any fungus is liable to appear where one is making trap exposures. This makes identification by hosts an impossibility. One can only surmise that the fungi so obtained came from the plants surrounding the place in which the exposures were made. Such identification, too, has led to almost endless confusion, because of the tendency to make just as many species as there are host plants. We have come to recognize that a fungus can not be determined alone by the host on which it occurs, since many species are cosmopolitan and omniverous in their conidial or hyphomycete form. The complete round of life, host, cultural characters and spore measurements all aid in determining the species with which we are dealing.

As the work progressed the constant presence of some forms in the exposures and the absence of others which were known to be present in the orchards, led to making exposures in other orchards. From them, suggestions were obtained, valuable both in themselves and in the fact that they were explanatory of results obtained in other places, though no attempt was made in any of these to make a regular serial set of exposures.

DISEASES OF APPLES.

Quite a number of diseases of apples occur in the state, and many of the causal organisms are known as regards cultural characters. The spores of many are known to grow upon glucose agar and so might be expected to appear in the trap cultures, provided viable spores were prevalent. The following tabulation will place these facts before us:

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*Thom: Journal of Mycology. 9:117-124. 1905.

NAME.	CAUSE	GROWTH FROM SPORE ON GLUCOSE AGAR.
1. Alternaria, rot and leaf spot	Alternaria sp.	Grows luxuriantly.
2. Bitter-rot	Glomerella rufomaculans (von S. and Sp.)	Grows luxuriantly.
3. Bitter-spot and Pink-mold	Cephalothecium roseum Cda.	Grows luxuriantly.
4. Black-rot	Sphaeropsis malorum Pk.	Grows luxuriantly.
5. Brown-rot	Sclerotinia fructigena (Pers.) Schrt.	Grows luxuriantly.
6. Fire-blight	Bacterium amylovorum (Burr.) Chest.	Grows luxuriantly.
7. Fly-speck fungus	Leptothyrium pomi (Mont. and Fr.) Sacc.	Not known.
8. Green mold	Penicillium expansum Lk.	Grows luxuriantly.
9. Illinois apple-tree canker	Nummularia discreta (Schw.) Tul.	Grows luxuriantly.
10. Leaf-spot	Phyllosticta sp.	Grows luxuriantly.
11. Powdery-mildew	Podosphaera leucotricha (Ell. and Ev.) Salm	Does not grow.
12. Rust	Gymnosporangium macropus Lk.	Does not grow.
13. Scab	Venturia inaequalis (Cke.) Aderh.	Does not grow.
14. Sooty-blotch	Phyllachora pomigena (Schw.) Sacc.	Not known.
15. Wound fungi	Various Basidiomycetes	Do not grow.

LIST OF FUNGI OBTAINED.

It was not expected that the fungi which might be prevalent would correspond entirely with those which were obtained. Those which were actually obtained in the exposures are as follows:

NAME OF FUNGUS.	NO. OF EXPOSURES MADE.	NO. TIMES OBTAINED.
Alternaria No. 1	27	27
Alternaria No. 2	27	10
Cladosporium No. 1	27	27
Cladosporium No. 2	27	5
Helminthosporum sp.	27	4
Penicillium expansium Lk	27	9
Oospora sp.	27	9
Phyllosticta limitata Pk.	27	24
Nummularia discreta (Schw.) Tul.	27	2
Sporotrichum sp.	27	1
Acremoniella cucurbitae, Schultz and Sacc.	27	1

Besides these several forms appeared in the cultures which were never made to produce conidia or perfect fruits and no idea as to their identity was secured.

The "green mold," *Penicillium expansum*, the "leaf-spot fungus," *Phyllosticta limitata*, and the "Illinois apple-tree canker," *Nummularia discreta*, were the only forms which were found, that are ordinarily troublesome in apple orchards.

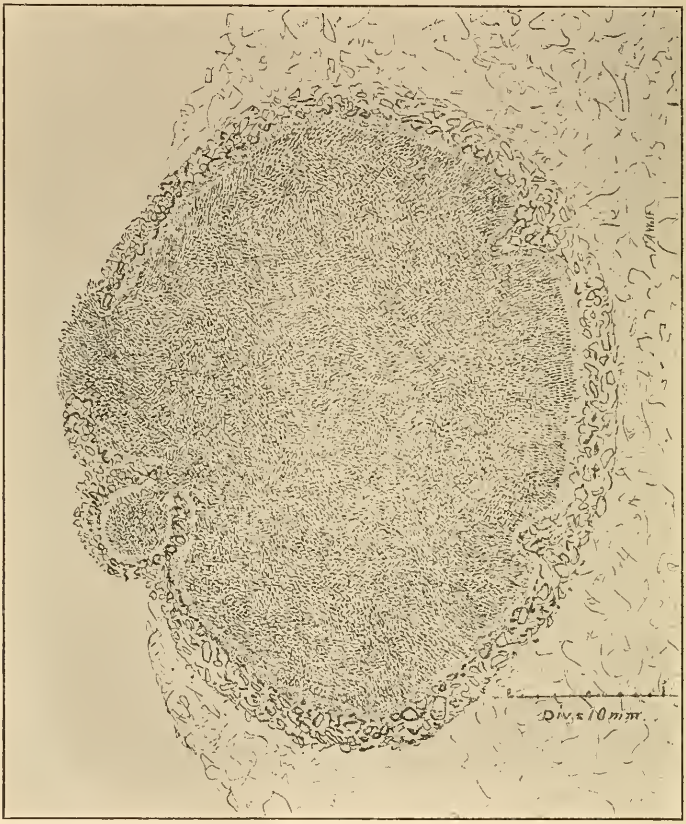

Fig. 1. Section of *phyllosticta limitata* pycnidium, grown on glucose agar.

RELATIVE ABUNDANCE.

Perhaps no better method could be employed in giving some facts concerning the relative abundance of living organisms than to arrange in tabular form some of the counts of the colonies as they appeared in the exposures. This fact can be as well represented by taking into account a part of the actual counts, as if the whole period during which the exposures were made was included. The table covers the results of eight consecutive exposures.

EXPOSURE I.

Station	Date	Weather conditions	Length of Exp'sre	No. fungus colonies	No. of yeast colonies	No. Bact. colonies	Total
1	Mch. 14	Warm, bright, Calm	1 min.	Cladosporium . . 2 Penicillium . . . . 2 Unknown . . . . . 1 Alternaria . . . . . 1— 6	0	0	6
2	"	"	"	Cladosporium . . 10 Alternaria . . . . . . 14 Phyllosticta. . . . 5—29	10	1	39
3	"	"	"	Alternaria . . . . . 1 Penicillium . . . . 1 Phyllosticta. . . . 1— 3	5	0	8
EXPOSURE II.							
1	Mch. 21	Warm, clear, very windy.	30 sec.	Cladosporium . . 2 Alternaria . . . . . 1 Phyllosticta. . . . 3 Unknown. . . . . . 1— 7	13 white	0	20
2	"	"	"	Cladosporium . . 5 Alternaria . . . . . 3 Phyllosticta. . . . 2 Unknown. . . . . . 1—11	11 white	1	23
3	"	"	"	Alternaria . . . . . 8 Cladosporium . . 2 Phyllosticta. . . . 1—11	red, 1 white, 7	0	19
EXPOSURE III.							
1	Mch. 28	mild, clear, gentle breeze.	1 min.	Cladosporium . . 2 Alternaria . . . . . 3 Phyllosticta. . . 1 Oospora. . . . . . . 1 Acremoniella. . . 1 Unknown. . . . . . 2—10	12 white	0	22
2	"	"	"	Alternaria 1	white 2 red 1	0	4
3	"	"	"	Cladosporium . . 2 Alternaria . . . . . 5 Phyllosticta. . . . 2 Oospora. . . . . . . 1—10	white 9	0	19

EXPOSURE IV.

Station	Date	Weather conditions	Length of Exp'sre	No. fungus colonies	No. of yeast colonies	No. Bac. colonies	Total
1	Apr. 4	Moderate, clear, windy.	1 min.	Cladosporium . . 22 Alternaria . . . . . 14 Phyllosticta. . . . 3 Oospora. . . . . . . 1 *Unknown . . . . . 1—41	70	3	114
2	"	"	"	Cladosporium . . 28 Alternaria . . . . . 18 Phyllosticta. . . . 3 Oospora. . . . . . . 2—51	54	1	106
3	"	"	"	Cladosporium . . 14 Alternaria . . . . . 13 Phyllosticta. . . . 5—32	92	3	127

EXPOSURE V.

1	Apr. 11	Mild, clear, calm.	1 min.	Cladosporium . . 12 Alternaria . . . . . 12 Phyllosticta. . . . 3 Penicillium . . . . 2 Oospora. . . . . . . 1 *Unknown . . . . 1—31	50	15	96
2	"	"	"	0	2	35	37
3	"	"	"	Cladosporium . . 3 Alternaria . . . . . 7 Penicillium. . . . 2—12	16	28	56

EXPOSURE VI.

1	Apr. 18	Clear, calm, day, following rain.	2 min.	Cladosporium . . 11 Alternaria . . . . . 7 Phyllosticta. . . . 1—19	0	10	29
2	"	"	"	Cladosporium . . 12 Alternaria . . . . 2—14	2	32	48
3	"	"	"	Cladosporium . . 14 Alternaria . . . . . 12—26	1	12	39

EXPOSURE VII.

Station	Date	Weather conditions	Length of Exp'sre	No. fungus colonies	No. of yeast colonies	No. Bac. colonies	Total
1	Apr. 24	mild breeze, warm, partly cloudy, day following rain.	2 min.	Cladosporium . . 14 Alternaria . . . . . 14 Phyllosticta. . . . 1 Oospora. . . . . . . 1—30	2	0	32
2	"	"	"	Cladosporium . . 3 Alternaria . . . . . 1 Phyllosticta. . . . 1— 5	5	0	10
3	"	"	"	Cladosporium . . 15 Alternaria . . . . . 20 Phyllosticta. . . . 3—38	2	0	40

EXPOSURE VIII.

1	May 2	clear, cold, moderate wind.	1 min.	Cladosporium . . 2 Alternaria . . . . . 2— 4	23	0	27
2	"	"	"	Cladosporium . . 11 Alternaria . . . . . 4 Phyllosticta. . . . 4 Oospora . . . . 3 *Unknown. . . . . 3—25	48	0	73
3	"	"	"	Cladosporium . . 8 Alternaria . . . . . 5 Unknown. . . . . . 1—14	16	0	30

DISCUSSION OF SAPROPHYTIC FORMS.

Cladosporium sp.—Two forms appeared in the cultures and have been designated in the list of fungi obtained as No. 1 and No. 2. No. 1 occurred much more commonly. It forms small, dark, olive green hemispherical colonies, which are black beneath, and as they grow older have one or more fissures as seen from below. The other, No. 2, forms a much larger colony of looser filaments, brown, with tinges of red near the margin.

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*Unknown fungus formed a very loose cottony mycelium but gave no hint as to its identity.

Neither one had any effect when they were used to inoculate apples.

Alternaria sp.—In the genus Alternaria we have a great variation in food habit. Some are parasitic, some saprophytic, and some facultative parasites or saprophytes.

Alternaria is one of the forms which has been found to cause a rot* and leaf spot† of apples. This form has been worked upon at the Station this year but did not appear in the trap cultures. The two forms which did appear differed from this Alternaria in cultural characters and food habit. No. 1 forms a thin, brown colony which lies close to the medium. No. 2 forms á gray, loose colony.

To get something of the habits of these two forms of Alternaria, inoculations were made on apples, which had been carefully sterilized by wiping with absorbent cotton moistened in mercuric chloride solution (1–1000). A small incision was made in the apple by means of a sterile scalpel and the spores transferred to the opening. After ten days the gray Alternaria had formed quite an extended zone of rotten tissue. The other Alternaria was not able to produce a rot.

Oospora sp.—This fungus when it appeared in the plates, formed small, shiny, radiate colonies, which soon became circular, due to the production of numerous spores. It was also used to make inoculations of apples, but it always failed to produce a rotting of the tissues.

Penicillium expansum Lk.—Penicillium is known to be saprophytic and to grow on almost every substratum which contains sugar. It is known to be very destructive among stored apples. No inoculations were made with any other of the fungi which appeared.

(Continued in August Number.)

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*Longyear: Bulletin Colorado Experiment Station. 105:1-62.
†Cooper: Alternaria on the Apple—Leaf and Fruit, Thesis, University of Nebraska, 1908.

CONDITIONS INFLUENCING THE GROWTH OF USNEA LONGISSIMA.

By Elda R. Walker.

I have been much interested in Mr. R. Heber Howe's article (Plant World, 13:3, March, 1910) in which he questions Mr. A. W. C. T. Herre's statements as to the effect of moisture on the growth of Usneas. I have spent most of my life in western Oregon, and, as I have seen *Usnea longissima* growing in the Willamette valley it is always on trees near a swale or stream, or in a low place where dew falls almost every night during the dry season. It is peculiar in that it always forms a very dense growth over one tree or a small group of trees and no other specimens will be found within miles. It seems to prefer localities quite protected from wind but not necessarily where "not yet visited by the lumberman" (Herre).

The finest growth of *Usnea longissima* I ever saw was found about a mile from the little village of Cornelius, Washington county, Oregon. It grew on a large vine maple (*Acer circinatum*) tree surrounded by a few smaller ones overhanging a small stream in a swale. This clump was a part of a narrow strip of wood following the swale and bordered on either side at only a distance of a few hundred yards by farm lands. Moreover, it is at an altitude of only about 150 feet above sea level, which is quite contrary to the statements of both Howe (Bull. Torr. Bot. Club, 36:6) and Herre (Wash. Acad. of Science, 12:2) who say that it is found only at an altitude of 1200 to 1500 feet. These authorities also speak of this Usnea only in evergreen forests, while the specimens to which I refer grew on deciduous trees. There are evergreens near by but none near enough to produce any shade at this place. The *Usnea longissima* hung so thickly from every limb of the group of trees that the space beneath was partitioned as by curtains. The threads hung straight to the ground showing no sign of disturbance by wind. In this place I removed numerous threads from 25 to 30 feet in length, and one 33 feet in length I sent to Doctor Charles E. Bessey of the University of Nebraska. The end of this and of several other strands I had to pull from the higher limbs in such a way that they broke, and I could not tell how much longer they might have been.

I believe that moisture and a mild climate are the essential factors in producing the luxuriant growth of this lichen, but undoubtedly lack of disturbance by the wind prevents the long threads from being broken and so gives longer individuals. In the coast mountains, and especially on the west slope, this species is more abundant and extends over wider areas, I am told, but I have not observed it there. Here again moisture and mild temperature are factors, the moisture being abundant throughout the year. Of course there is a long growing period, but that is due entirely to the mild climate and moisture combined. Without either, growth must soon cease.

One fact that has interested me is that Usneas disappear in towns and along railroad tracks. It is said that smoke from chimneys kills them. The only point I can suggest to substantiate this is that along a certain railroad on which wood and coal were burned the Usneas became very rare. A few years ago petroleum was adopted as a fuel and last summer it seemed to me the Usneas were becoming more abundant. Why petroleum smoke should be less injurious I can not say, and my conclusions may be apparent rather than real.

FORMATION OF ADVENTITIOUS ROOTS BY THE HACKBERRY TREE.

BY F. A. WOLF.

An interesting case of the formation of adventitious roots by the hackberry, *Celtis mississippiensis* Bosc., was noticed upon the campus of the University of Texas. This phenomenon is not new, as recently * a very similar example was reported on the Umbrella China tree, but as it is not common, it is worthy of consideration.

During a storm the trunk of this large hackberry tree had been split and the fallen portion was subsequently removed. At a point about eight feet above the ground and a little above the broken edge of the tree a cluster of fibrous roots were formed.

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*Ball, O. M., Bot. Gaz., 46:303-4. 1908.

Some of these grew to be over a foot in length and larger in diameter than a lead pencil.

While there is no doubt that no such phenomena would be expected to occur in a normal healthy tree, yet this is not an adequate explanation for their formation. Certain it is that the vitality of the tree had been seriously impaired and it responded to this abnormal condition by a peculiar development of roots. It would seem, too, that such a growth might better be expected in a more humid region and not under semi-arid conditions such as prevail about Austin. This is one of the singular, natural phenomena the reason for which can only be a matter of conjecture.

University of Texas.

BOOKS AND CURRENT LITERATURE.

A notable contribution to our knowledge of the physiology of bog plants is made by Dachnowski in a paper entitled "Physiologically Arid Habitats and Drouth Resistance in Plants," which appeared in the *Botanical Gazette* for May, 1910. The author had already shown that the physiological effect of bog water and bog soil plays a primary role in the determination of the flora that can best succeed in bogs, the conclusion being drawn in part from laboratory experiments in which it was demonstrated that various plants exhibited marked differences in their power of resistance to the toxic action of the substratum in question, which thus becomes a definite factor in determining both the character and distribution of plants in such a habitat.

In the present paper the character and development of drouth resistance in bog plants has been made the subject of extended experimental study, and the data accumulated and conclusions drawn throw light on what has heretofore proven an extremely baffling problem. Dr. Dachnowski shows, conclusively it would seem, that drouth resistance involves a specific reaction on the part of the plant to more than one factor of the physical and biotic environment, and that such resistance in physiologically arid habitats is due to a specific protective functional root activity. Cultures of isolated bog bacteria show that the injurious products of the bacterial bog flora accumulating in definite layers of the peat substratum are the leading factors in producing physiological aridity, and it also appears that this bacterial flora plays an important part not only in the formation of toxins, but also in the slow and partial decay of bog and swamp plants; and this retardation of growth appears plainly to be caused, not by physical or chemical conditions, but through the direct activity of the bacterial flora upon the peat substratum.

The extended study of physiological factors which has been made by the author leads to the conclusion that, contrary to accepted views, low substratum temperatures play no part in bog structure or bog development. It appears also that the evaporating power of the air in bogs is not an important limiting factor in controlling bog vegetation, or determining the character of it. There is, on the contrary, a vapor blanket over the surface of bogs which conserves the moisture that would otherwise be lost by evaporation. Hence the weight of evidence is again decidedly in favor of the conclusion that the real determining factor in the bog habitat is the ratio of the possible rate of water absorption to the rate of transpiration, and that the toxicity of the bog habitat has a primary role in bringing about bog conditions.

The first part of Professor Edward Lee Greene's "Landmarks of Botanical History" has appeared as part of Volume 54 of the Smithsonian Miscellaneous Collections. Its sub-title, "A Study of Certain Epochs in the Development of the Science of Botany," indicates the author's purpose, which, as more fully set forth in the preface, is "to evade the responsibilities of the consecutive historian, thus leaving him free to bring into clearer light the lives and teachings of those and those only among botanists of the past whose names are more familiar."

The spirit of the undertaking is further shown by the words "The historian who is both conscientious and discreet will give small heed to popular opinion about any particular man or epoch. Neither the adulation of the multitude is of any profound import, nor its voiceless indifference. Its outspoken opposition or denunciation may even be the highest praise." Needless to say that a work conceived and executed from this standpoint contains much that is of great interest, whether it meets the approval of the reader or not. Its more extended review is reserved for the publication of the remaining part.

In 1903, Mr. George W. Oliver, plant propagator of the Bureau of Plant Industry, undertook a series of experiments in plant breeding which involved the crossing of varieties of lettuce, alfalfa, and cowpea. The bulletin (U. S. Department of Agriculture, Bureau of Plant Industry, No. 178) which gives in detail the methods used and originated in the accomplishment of this was issued in February, 1910, under the title "New Methods in Plant Breeding."

Both lettuce and alfalfa required special manipulation to prevent self or random cross fertilization. In the former case, Mr. Oliver was finally successful in washing the stigma entirely free from pollen without injury by means of a jet of water. He gives a full description of the process and the instruments used. The devices used for lettuce were also useful for other Compositae.

In alfalfa, the flowers which were selected to furnish pollen were first "tripped" *i. e.* the stigma was released from the sexual column without releasing the pollen from the anthers by the use of a small pin. The anthers were then removed for future use. The seed-bearing flower was then tripped in the same way and the stigmas kept from pressing against the banner by the pin. After washing with a jet of water it was ready for pollination.

The size of the cowpea flower made emasculation and depollination a much simpler matter. The processes are fully described, and there are chapters upon methods of emasculating and depollinating common flowers, crossing cultivated varieties and natural species, hybridizing species, etc. The paper is well illustrated.

In a bulletin entitled "The History and Distribution of Sorghum," (U. S. Dept. Agr., Bu. Pl. Ind., Bull. No. 175), Mr. Carleton R. Ball, after having raised experimentally over 1200 different varieties, sets forth the origin and antiquity of sorghums, together with their present distribution and culture. The chief types or groups now found in each of the major geographical areas are briefly described, the conditions under which they have developed are pointed out, and their probable adaptations in our own land are indicated. The term "sorghum" is here used in its most comprehensive sense, including all the groups popularly known as sorgo or sweet sorghum, kafir, broom corn, shallu, kowliang, durra, and milo.

The bulletin is divided into two parts, agricultural history and distribution, and botanical history and nomenclature. In regard to the former he concludes that "many facts point to an independent origin in tropical Africa and in India, which are the two great centers of sorghum production, each occupied by an enormous number of varieties."

NOTES AND COMMENT.

It is the wish of the management of the PLANT WORLD to make this journal more than at present a record of actual progress, particularly as regards the work of American botanists. To this end, teachers, investigators, and other readers are again invited to contribute notes of observations, facts accumulated in the course of research, suggestions drawn from teaching and field work, and short paragraphs of all sorts that may be interesting to botanists old or young and in any department of botanical work. Long papers by specialists have accumulated in the editorial drawer until it has become a serious problem what to do with them. The art both of selection and condensation needs to be assiduously cultivated by many, even of our best writers.

The rubber craze still continues in London (or did when this was written) with very little to relieve the sordid aspects of an extraordinary episode. The history of the tulip mania brings up pictures of people who became mad over beauty and color, but rubber—fit emblem of all that is tough, elastic and formless in modern life and morals! None the less it is a matter of congratulation that a number of well known botanists have engaged in a thorough investigation of certain rubber-producing plants, and there is every reason to expect that the better knowledge thus obtained of actual conditions of growth and reproduction will eliminate something at least of the speculative element in the future history of this indispensable product. One of the latest to devote himself to this investigation is Dr. J. B. McCallum, of the Arizona Experiment Station, who will carry on his practical work in large part at the Desert Laboratory at Tucson.

The program of the Fourth Session of the Graduate School of Agriculture, which will be held July 4-29, at Ames, Iowa, includes lectures on Plant Physiology and Pathology as follows:

Dr. C. E. Bessey: A Little Embryology. The "Water Department" of Plants. The Great Business of Plants. Plant Eggs and Sperms. The Sun and the Plant.

Dr. D. T. MacDougal: Physiology of Genetics. Acclimatization. Direct Influence of External Factors on Plants. Ovarial Treatment of Plants. Desert Vegetation.

Prof. Haven Metcalf: Forest Pathology. Diseases of Ornamental Trees and Tree Surgery. New or Little-Known Laboratory Methods and Apparatus. Plant Diseases and Legislation. Bibliographical Methods in Plant Pathology.

Dr. L. H. Pammel: The History of Vegetable Pathology. The Factors Controlling the Diseases of Plants. The Ustilagineae Affecting Cereal Plants. The Uredineae Affecting Cereal and Other Plants. Certain Root-Rot Diseases of Plants.

Dr. G. E. Stone: General Principles of Plant Physiology.

Dr. F. L. Stevens: History and Development of Plant Pathology. The Consideration of the Needs of Present Plant Pathology. Discussion of the Pedagogy of Plant Pathology. Soil Diseases.

Dr. E. Von Tschermak: Conditions of Blossoming, with Special Reference to Pollination and Infection from Rust and Smut. Questions of Fecundation and Transmission, (Two lectures.) The Problem of Correlation with Special Reference to Plant Breeding. Discussion of Plant Breeding Methods Practiced in America and Europe.

Dr. H. J. Webber: General Principles of Plant Breeding.

Agronomy.

Dr. C. G. Hopkins: The Meaning of Soil Analysis. The Permanent Maintenance of Soil Fertility. Methods of Soil Investigation and Interpretation of Results.

Dr. J. G. Lipman: The Soil as a Culture Medium (Two lectures.) The Quantitative Estimation of Bacterial Changes in the Soil (Two lectures.) Bacterial Activities in their Relation to Soil Management.

Prof. C. V. Piper: Soil Variation as a Factor in Field Experiments. Plant Variation as a Factor in Field Experiments. The Essentials of a Field Experiment. The Recording and Publication of Field Experiments. Methods of Obviating Minor Errors in Field Experiments.

Dr. L. H. Smith: Some Results Accomplished by Selection. Some Fundamental Problems of Selection.

Prof. W. H. Stevenson: Undergraduate courses in Soils. Some Physics Problems. Data Regarding Some Special Soils.

Dr. S. L. Jodidi: Humus with Special Reference to Soil Nitrogen (Two lectures.)

To the above will be added lectures on horticultural subjects by a number of well-known specialists.

Volume 13 Number 8

THE PLANT WORLD

A MAGAZINE OF GENERAL BOTANY

AUGUST, 1910

ROCKY MOUNTAIN RAMBLES

By L. H. PAMMEL.

(Continued from July Number.)

Two species of mountain mahogany occur, one the *Cercocarpus parvifolius*, smaller and more widely distributed in dry situations, may be found growing with the *Purshia tridentata* and the mountain maple (*Acer glabrum*). The larger species (*C. ledifolius*) occurs only in the most exposed situations in rocky soil. A small hard maple (*Acer grandidentatum*) occurs along the mountain streams, common everywhere in Utah. The dogwood (*Cornus stolonifera*) and the birch (*Betula fontinalis*) are common in similar situations. The salmonberry (*Rubus Nutkanus*) is common along brooks in Utah at an altitude of 6,000 feet, but northward, in the Bitter Root mountains, and in Washington and Oregon occurs abundantly in the canyons and moist situations at a much lower altitude. The box elder (*Acer Negundo*), known as a common, ugly-looking tree along our streams in Iowa, is a most beautiful one in Utah, especially when cultivated, as it frequently is. It has a clean, straight trunk. The cottonwood (*Populus angustifolia*) is everywhere a common tree along the streams of Utah. In the Uintah Mountains the writer has seen it frequently at an altitude of 8,500 feet. Westward, the species is replaced by the black cottonwood (*Populus trichocarpa*). This is true especially in the streams of Oregon and Washington. It is a magnificent tree in the valleys of the Columbia and Williamette.

The quaking aspen (*Populus tremuloides*) is everywhere common in the Rockies, the Uintah, and the Wasatch mountains. It occurs everywhere with the lodge pole pine, but extends much farther down, marking the limit of tree growth down the mountain side, frequently forming extensive forests. The herbaceous plants in these forests are the same as found in pine forests, Astragalus, Lupines, Larkspurs, Poas, Polemoniums, etc.

The sage brush (*Artemisia tridentata*) is found not only on the east slope of the Rockies, but in the great interior basin in southern Idaho to the foothills of the Blue Mountains and eastward from the Cascade Mountains. In this interior country it reaches its greatest size. Along the streams, especially Snake River, there is a great deal of what is commonly called the cottonwood (*Populus angustifolia*); on the banks of the stream the sandbar willow (*Salix fluviatilis*), an abundant species;while a form of the almond leaf willow (*Salix amygdalordes*) is common. The shiny willow (*Salix lasiandra*), a beautiful species which should be cultivated in the eastern states, is abundant at higher altitudes in the Rockies, the Uintahs, and the Wasatch mountains. Of the roses, the most conspicuous along the streams is the Fendler's Rose (*Rosa Fendleri*). On the dry,

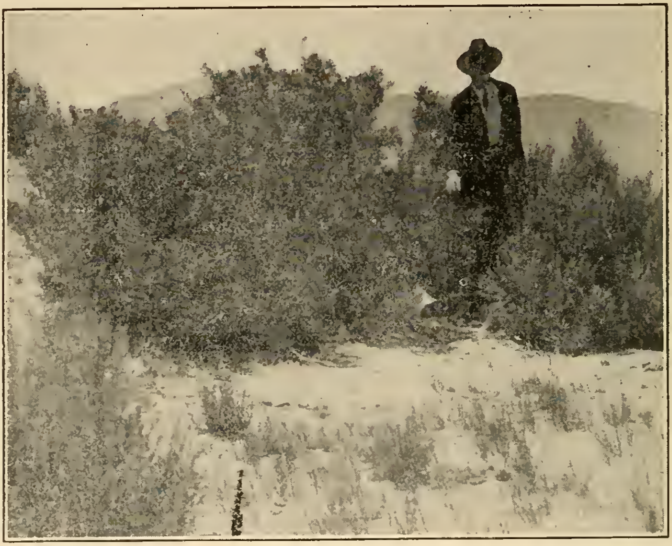

Fig. 1. The Sagebrush (*Artemisia tridentada*) in the Salt Lake Basin, Utah, with Salt Grass (*Distichlis spicata*) in the foreground. Photo by L. H. Pammel.

arid plains Buckley's meadow grass (*Poa Buckleyana*) is common, and occasionally the *Oryzopsis cuspidata* may be seen. This species is common east to the Nebraska sand hills, and abundant on the plains of Colorado, New Mexico, and the Dakotas. The widely distributed needle grass (*Stipa comata*) also occurs; on the dry and rocky hills in the basin country the western red cedar (*Juniperus occidentalis*) occurs in scattered groups. It is the only conifer found on these dry, rocky lava beds.

Fig. .2 *Pinus albicaulis* in the Bitter Root Mountains at 7 500 feet altitude.

The great basin country in Utah and the adjacent region of Wyoming is chiefly interesting because of the large number of purely desert species. Salt Lake City, with a rainfall of about 15 inches, has a rich vernal flora and soon gives away to a few perennial woody, deep-rooted plants. The sage brush (*Artemisia*) several species, *Sarcobatus vermiculatus*, *Atriplex Nuttallii*, *Argemone hispida*, are conspicuous plants on the dry plains.

The spinescent composite *Tetradymia Nuttallii*, is common near Green River. Of course, throughout this region *Helianthus petiolaris, Cleome serrulata and Distichlis spicata* are common. Other maritime plants belonging to the genera *Spartina*, *Kochia*, *Scirpus*, *Suaeda*, *Salicornia*, and *Hordeum* are abundant.

I have been much struck by the extraordinary number of European plants which have become established in Utah. Many of these were no doubt introduced by the early Mormon settlers. Everywhere in the streets one can see the caraway (*Carum carvi*), lovage (*Levisticum officinale*),poison hemlock(*Conium maculatum*), carrot (*Daucus carota*), chicory (*Cichorium Intybus*), peppermint (*Mentha piperita*), spearmint (*M. spicata*), horehound (*Marrubium vulgare*), catnip (*Nepeta Cataria*), wormwood (*Artemisia stellariana* Bess.), tansy (*Tanacetum vulgare*), mayweed (*Anthemis cotula*), pineapple weed (*Matricaria suaveolens*), Canada thistle (*Cirsium arvense*), bull thistle (*C. lanceolatum*), mullein (*Verbascum Thapsus* and *V. Blattaria*), buckhorn (*Plantago lanceolata*), black medic (*Medicago lupulina*), sweet clover (*Melilotus alba*). The storksbill (*Erodium cicutarium*), *Bromus tectorum*, *Hordeum murinum* have spread rapidly and are a great detriment to the stock industry.

Leaving the volcanic lava fields of Idaho we may pass on to the Blue Mountains of eastern Oregon. The flora here is much more Rocky Mountain than Cascade. The bull pine (*Pinus ponderosa*) at lower altitudes in the mountains attains great size, often more than 150 feet high and six feet in diameter; at higher altitudes the lodge pole pine (*Pinus Murrayana*) occurs from Oregon to British Columbia. Other conifers occurring at higher altitudes are the Engelmann spruce (*Picea Engelmanii*) and the *Larix Lyalii*, sometimes a timber-line tree, as well as the *Tsuga mertensiana* in British Columbia. The Douglas fir (*Pseudotsuga Douglasii*) occurs at lower altitudes and does not, however, attain its maximum height and development until the west slope of the Cascades is reached. The shrubby cinquefoil (*Potentilla fruticosa*) is common in the marshes in the Uintah Mountains at higher altitudes. The large-leaved aven (*Geum macrophyllum*), the blue-flowered lupine (*Lupinus leucophyllus*), the yellow-flowered bitter-weed (*Thermopsis montana*), and the purple flowered monkeyflower ((*Mimulus Lewsii*) growing near springs and brooks in mountain marshes, and the purple lousewort (*Pedicularis groenlandica*) are common. Acres of these may be seen below timber-line in many of the mountains of Colorado and Utah. Some of these reach over into the Cascades, especially northward.

At the Dalles, in eastern Oregon, on the Columbia, on the eastern slope of the Cascades, with a comparatively small rainfall, wheat and other small grains are grown without irrigation. Peach and other fruit trees are plentifully planted in the valley of the Columbia. The sandbars formed by the drifting sands from the Columbia River for many miles down the stream are interesting; they are ever changing and were it not for the "sand-fences" erected by the Oregon Short Line, these drifting sands would soon cover the tracks. Towards the stream these dunes are often covered with a willow, known as the Columbia sandbar willow (*Salix sessilifolia*), which grows abundantly in this valley. These bars, when moist enough, become covered with grasses, followed later by this willow.

In the bottoms along the stream near Hood River, one begins to see large trees of the black cottonwood (*Populus trichocarpa*) from 2 to 4 feet in diameter, attaining a height of 150 feet, although on the west slope of the Cascades along other streams and the Columbia it may attain a diameter of 8 feet and a height of 200 feet. It is the most magnificent of our poplars. It is largely used for making excelsior and boxes.

The slopes and valleys were covered with an abundance of bull pine (*Pinus ponderosa*) in an early day before the forests gave way to garden and field. The western larch (*Larix occidentalis*) was abundant on the slopes and has furnished much lumber; up the valley and on the mountain sides the Douglas fir the western hemlock (*Tsuga heterophylla*) and red cedar of Washington (*Thuja plicata*) become more abundant. The mountain sides are covered with great masses of the *Aruncus vulgaris*, with ample panicles of white flowers. The trailing *Rubus ursinus* is common everywhere in the woods.

The mighty forests of Douglas fir, cedar, hemlock, larch (*Larix Lyalii*) and spruce have in large part long since been removed in the vicinity of Portland, but everywhere a vigorous young growth of these conifers is appearing. Only a short distance from Portland, at Creighton, a suburb, one may still see some of the giants of the forest. A few mighty firs and cedars are abundant in the valleys, and at Vancouver, across the river from Portland, several of these monarchs occur on the grounds of the military reservation. The woods about Portland are interesting. Though it be in the summer, during the dry season, there is a vigor to the vegetation not seen in our eastern forests. I was shown a young forest of Douglas fir which thirty years before had been in an oat field. The young trees were 50 and 60

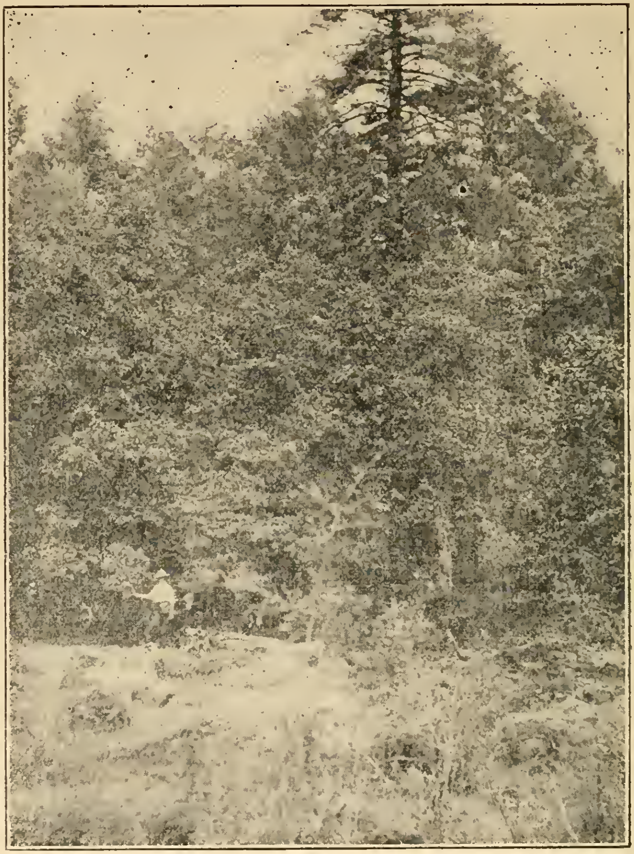

Fig. 3. A dense growth of Alder (*Alnus oregana*), Dogwood (*Cornus nuttallii*) and a Douglass Fir near Portland, Oregon. In the foreground a swamp, the vegetation consisting largely of sedges, grasses and vetches.

feet high and many of them were 18 to 20 inches in diameter. One is astonished to see how quickly the forest species occupy the vacant soil, when left to itself. The rainfall in Portland is about 50 inches, some years less and some years more. Astoria has a rainfall of about 75 inches or more some years, 77 to 84 inches in 1891, near Cascade Lake in the heart of the Cascades 87.35 inches. Hood River, on the Columbia near Mount Hood, only 36.68 inches. The trees do not have near the vigor at this point as near Portland. The yellow pine is more abundant than where the precipitation is greater. The Dalles, on the Columbia, to the east of the Cascades, is a region that is more desert like, with an annual precipitation of only a little over 12 inches.

Some of the enterprising horticulturists have made experiments with various eastern species. The European trees usually do very well; there are splendid orchards of sweet cherries, apples, and pears. Our eastern shag-bark hickory and the white oak, however, make only a very slow growth. The redwood of California (*Sequoia sempervirens*) is perfectly hardy. The giant redwood (*S. gigantea*) is also hardy. The *Libocedrus decurrens* and white cedar (*Chamaecyparis Nootkatensis* and *C.Lawsoniana*) also succeed. Splendid specimens occur near Portland. One is interested in the deciduous trees and shrubs found here. The western dogwood (*Cornus Nuttallii*) with its large white bracts, surrounding small flowers crowded in a loose head, and its bright and shiny leaves is abundant everywhere. The madrone (*Arbutus Menziesii*) a small tree with exfoliating bark and the white oak (*Quercus Garryana*) and ash (*Fraxinus oregana*) are common in rocky places. The swales are lined with the western wild apple (*Pyrus rivularis*) and the undergrowth contains an abundance of beaked hazel (*Corylus californica*) the wood of which is used for making rustic chairs and other furniture. The *Spiraea Douglasii*, well-known in cultivation, as well as the *S. lucida*, is common in the woods throughout the region. I enjoyed a small outing to Creighton, near Portland. The small village is easily reached by an electric line and a short walk will take one to the woods, the deep recesses with their firs and cedar. At this point Mr. Thomas Howell lives. This farmer botanist is the author of a Flora of Northwest America. He has enriched science by a large number of new species of plants. I spent a pleasant afternoon with him. In conversation with him I learned that he is a self-made man. His school advantages were very meager, but in his desire to become familiar with the plants of Oregon specimens were sent to Dr. Asa Gray of Harvard University, from whom he received his inspiration to explore the botany of the region. He has sent plants to every institution of note in this country and abroad.

One should not fail to make a trip to the coast down the Columbia to Astoria and the vicinity. Astoria is famous because it was here that Lewis and Clark spent their winter on their exploring expedition; and later it became a trading post. Not much of the glory of the great forests remains about Astoria Taking the railway we pass the various small stations; the names of one or two remind us of the Lewis and Clark expedition. There is Tilamook Head, Fort Clatsop, and other familiar names of this expedition. It will be remembered that Lewis and Clark named their fort Fort Clatsop. Fruit trees seem to do well. The atmosphere is so heavily laden with moisture most of the year that the trees become thickly covered with lichens. Everywhere along the coast the Scotch broom (*Cytisus scoparius*) has become naturalized. The region about the mouth of the Columbia is known as the Tilamook country. The low meadows are rich in grasses like cheat (*Bromus pacificus* and *B. Hookerianus*), meadow grasses, like *Poa macrantha* and *P. confinis*, and common blue grass (*P. pratensis*) which has become naturalized everywhere. The velvet grass (*Holcus lanatus*) grows in profusion not only in western Oregon but throughout the Cascade region in Washington. Two vetches, the *L. maritimus* and a larger species *L. polyphyllus* are common near the coast. As we speed along through forest and meadow we reach Gearhart Park, a small summer resort. Here we spend a most delightful time in the woods. The great trees of the Sitka spruce (*Picea sitchensis*) found only along the sea coast, are said to be the largest trees in Oregon, rometimes reaching a height of 300 feet and a diameter of 20 feet. I saw none as large as this, but it was a virgin forest with its spruce, hemlock, cedar, and giant brakes (*Pteris aquilina*) along the railway. These were as high as I could reach. The clearing along the railroad abounds with the fire weed (*Epilobium angustifolium*). This plant follows a fire and thousands of acres are covered by this weed in Washington and Oregon. Where little openings had been made for farms our eastern foxglove (*Digitalis purpurea*), the little *Linaria cymbalaria* and pansy (*Viola tricolor*) were running wild. The salal (*Gaultheria Shallon*), with black rather sweetish fruit, was common with smaller specimens of spruce and hemlock. The beach of the Pacific was only a few miles away. Here the stunted pine (*Pinus contorta*) occurred, forming the first belt of timber on the beach. This I believe to be different from the *P. Murrayana* which Sudworth places with *P. contorta.* The pine is followed by the Sitka spruce, hemlock and cedar. The original of our cultivated strawberry (*Fragaria californica*) grew abundantly on the sand dunes and beach away from the tides.

The country between the Wasatch Mountains in Utah to the Cascades in Oregon has an interesting vernal flora, but the flora of the Cascade Mountains of Washington is much like that of western Oregon. There are forests of Douglas fir, or, as it is known in Washington, the Washington fir, while in Oregon it is commonly called the Oregon fir. That is the commercial name for the timber. The magnificent forests of this species in Washington do not have an equal anywhere else in the United States; and this is not surprising if we take into account the rainfall which in the Puget Sound country is about fifty inches, though more in some and less in other years, while up in the higher Cascades, near Seattle, it is one hundred inches and even reaches one hundred and fifty inches. Under such climatic conditions the seeds of trees germinate readily and grow at once and continue to make a vigorous growth. These great forests then are due to the climatic conditions of the region. On the east slope of the Cascades in Washington the rainfall is much less, and one finds here the bull pine (*Pinus ponderosa*) interspersed occasionally with the beautiful white pine (*Pinus monticola*) which sometimes reaches a height of 200 feet and a diameter of 6 feet, there are many trees over 100 feet high and 3 or 4 feet in diameter. It requires more moisture than the bull or yellow pine. The tree resembles our eastern white pine but is more slender and with slender spreading or somewhat drooping branches; like the white pine the leaves are bluish-green and glaucous. It is a more beautiful tree than its eastern cousin. The Balm of Gilead poplar is common; brambles, rose and salmon berry abound in the wood.

Farther eastward we have an elevated plateau made up largely of disintegrated lava beds. The summers are hot and they have brief cold spells in the winter but these are tempered by the Chinook winds. The Palouse, Spokane, Yakima, and Walla Walla countries are well-known. The Spokane country is much drier, the annual precipitation being about 16 inches. Here the *Pinus ponderosa* develops perfectly, and along with it the sage brush (*Artemisia tridentata*) and many xerophytic grasses.

The forests of the Cascades on the coast may consist of many pure stands of the fir with many trees 8 and 9 and even 10 to 12 feet in diameter, or they may be interspersed with the western hemlock (*Tsuga heterophylla*) from 2 to 6 feet in diameter, and from 100 to 200 feet high, or the Washington cedar (*Thuja plicata*), a magnificent and graceful tree from 100 to 200 feet high and from 2 to 12 feet in diameter at the base, and a large fir (*Abies grandis*) and an occasional spruce (*Picea*). The forests reach to the very edge of Puget Sound and skirt the shore lines of the streams and lakes.

THE PREVALENCE OF CERTAIN PARASITIC AND SAPROPHYTIC FUNGI IN ORCHARDS AS DETERMINED BY PLATE CULTURES.

BY FREDERICK ADOLPH WOLF.

(Continued from July Number.)

DISCUSSION OF PARASITIC FORMS.

1. *Phyllosticta limitata Pk.*

a. Historical.—It has generally been conceded that the leaf-spot of apples was caused by *Phyllosticta limitata* Pk. The disease, in its economic aspect, was first mentioned by Alwood[*] in 1892. He described it as a "brown spot" on the foliage and attributed the cause doubtfully to *Phyllosticta pirina.*

Kinney[†] cited the same fungus as the cause of leaf-spot in Rhode Island in 1895.

Stewart[‡] in 1896, reported a leaf-spot in Long Island which Peck decided was caused by a fungus which he named *Phyllosticta limitata.*

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[*] Alwood: Bulletin Virginia Agricultural Experiment Station. 17:59, 62. 1892.
[†] Kinney: Annual Report Rhode Island Agricultural Exp. Station. 17:188-189. 1895.
[‡] Stewart: Annual Report New York Agricultural Exp. Station. 14 (1885):545-546. 1896.

In 1898 Alwood* found that *Sphaeropsis malorum* Pk. was very commonly associated with *Phyllosticta pirina* on leaf-spots.

The parasitism of *Phyllosticta pirina* and *P. limitata* was questioned in 1902 by Stewart and Eustace.† They said that the fungi live saprophytically on leaves injured by spray or on unsprayed trees on leaves injured by atmospheric conditions. They cite as an instance that when the sun comes out brightly after a shower, the drops of water act as lenses and overheat the tissue. It would, however, seem quite probable that the heat of the sun would evaporate the water before any injury had resulted and that the water would have a cooling rather than heating influence, in that the heat would be used in the formation of vapor.

In 1892 Clinton‡ found *Sphaeropsis malorum* to be the cause of leaf-spot in Illinois and in 1903** in Connecticut. He said that this fungus produced larger, more irregular spots than Phyllosticta.

Phyllosticta pirina Sacc., because of its smoky spores, was transferred to *Coniothyrium pirina* Sacc. by Sheldon†† in 1907. As a result of experiments in 1906 and 1907 in the Ozarks, Scott‡‡ found that the leaf-spot is caused by *Sphaeropsis malorum* and that *Coniothyrium pirina* which is associated with it has apparently nothing to do with the formation of the spots.

The Phyllosticta which appeared in these cultures was not smoky-spored, but belonged to the true genus, Phyllosticta. It causes a leaf-spot of the apple. In this region Ben Davis and Winesap are the most susceptible varieties. On the leaves, small, circular, brownish areas are formed, and immersed in this dead tissue the pycnidia are formed, always few in number.

(*b*) *Prevalence.*—No one fact is more surprising about *Phyllosticta limitata* than its persistent appearance in the trap cultures. It is not at all to be expected that it would be viable all through the year. Throughout December, January and March it was always present in abundance. It never failed to appear in the cultures, even during the coldest periods of the winter.

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*Alwood: Proc. Am. Assoc. Adv. Science. 47:413. 1898.
†Stewart & Eustace: Bulletin N. Y. Agricultural Exp. Station. 220:225-233. 1902.
‡Clinton: Bulletin Ill. Agricultural Exp. Station. 69:192-193. 1902.
**Clinton: Annual Report Conn. Agri. Station. 298. 1903.
††Sheldon: Torreya. 7:142-143. July, 1907.
‡‡Scott: Bulletin U. S. Dept. of Agriculture, Bureau of Plant Industry. 121:(3). 1908.

In an exposure made October 30th, during a drizzling rain, no Phyllosticta appeared. The only period of any length when it was not secured was during February. On February 2nd, two days following a heavy fall of snow, when the trees were still laden with snow, no Phyllosticta was found. Only a few colonies of Cladosporium and Alternaria appeared. Before the next exposure, February 8th, there had been another snow and the ground and trees were again covered. This time only a few colonies of Cladosporium and Penicillium appeared. Because of inclement weather no exposures were made until February 27th. At this time the plates again contained a good seeding of Phyllosticta. Since then it has appeared, without fail, in every set of exposures.

There are those who hold that the Fungi Imperfecti, to which Phyllosticta belongs is an artificial group, which will be merged into the natural groups as the complete life histories are determined. A form with such extremely resistant spores would seem to require no perfect stage. The chances are that it has no other stage than the pycnidial and so can never be merged with those forms which produce perfect fruits. The pycnidial form is so well adapted that no other is necessary to insure the maintainence of the species under adverse circumstances. If it ever had a perfect stage it has probably ceased to function.

(*c*) *Cultural Characters.*—In cultures on glucose agar, *Phyllosticta limitata* has a very characteristic appearance, forming a deep red pigment, at first faintly pink, but deepening as the colony matures. In slant tubes on this medium pycnidia were formed last October and November. They were produced evenly over the surface and slightly immersed. When the pycnidia were placed on a slide with a cover-glass over them, the hyaline spores formed coiled strands extending the entire length of the microscopic field, indicative of the copious spore production.

(*d*) *Inoculations.*— Since there has been some doubt as to the parasitism of *Phyllosticta limitata*, the fungus was used for inoculation experiments. The hyphae were used for inoculation on apples that had been carefully sterilized with mercuric chloride solution. In the course of eight days they produced spots of rotted tissue one-half inch in diameter.

Some fresh leaves of Winesap and Ben Davis were placed in sterile damp-chambers. Some of the hyphae were placed upon the surface of the leaves. In a short time the characteristic circular spots were formed similar to those attributed to Phyllosticta under natural conditions. These leaves were again washed for a minute in mercuric chloride solution, rinsed off in sterile water, and the spots removed and placed in glucose agar plates. From the tissue of the spots filaments came which gave the characteristic red color to the glucose agar and the further growth proved that the cultures were *Phyllosticta limitata*.

Leaves which were collected last fall were washed in mercuric chloride solution and then in water. Spots showing pycnidia were cut out and transferred to glucose agar plates. These, too, gave colonies, whose cultural characters were such as have been found in the exposures.

Since last autumn the fungus has not formed pycnidia in any of the various media tried, consequently no spores have been available for inoculations.

2. *Nummularia discreta* (Schw.) Tul.

Nummularia discreta is the fungus which causes the canker popularly known as the "Illinois apple-tree canker."* It is one of the wound parasites, entering through the wounds left by pruning or through those caused by the harness or apparatus used in cultivation. The brown spherical spores germinate very readily in water, so that the spores which lodge on the moist surface of a wound are in very favorable condition for germination. The hyphae penetrate into the tissue of the tree, killing the elements as they advance.

In its early stages the bark has a dirty, brown appearance. The spot which is cankered is usually depressed, small at first and gradually increasing in size. Between the cankered and living tissue there is always a distinct line of demarcation. The depression is caused partly by the drying out of the tissue and partially by the increased thickness of the sound bark. Late in the summer or in the autumn the stromata are formed beneath the bark. In sectional outline these stromata are cup-shaped. As the stroma grows older a ring of black stromatic tissue is formed beneath the disc. This ring extends through the bark and into the wood. Later the stromata crack and rupture the bark, exposing the gray spore-cushions, 1-8 to 1-4 inch

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*Hasselbring: Bulletin Ill. Agri. Exp. Station. 70: 1902.

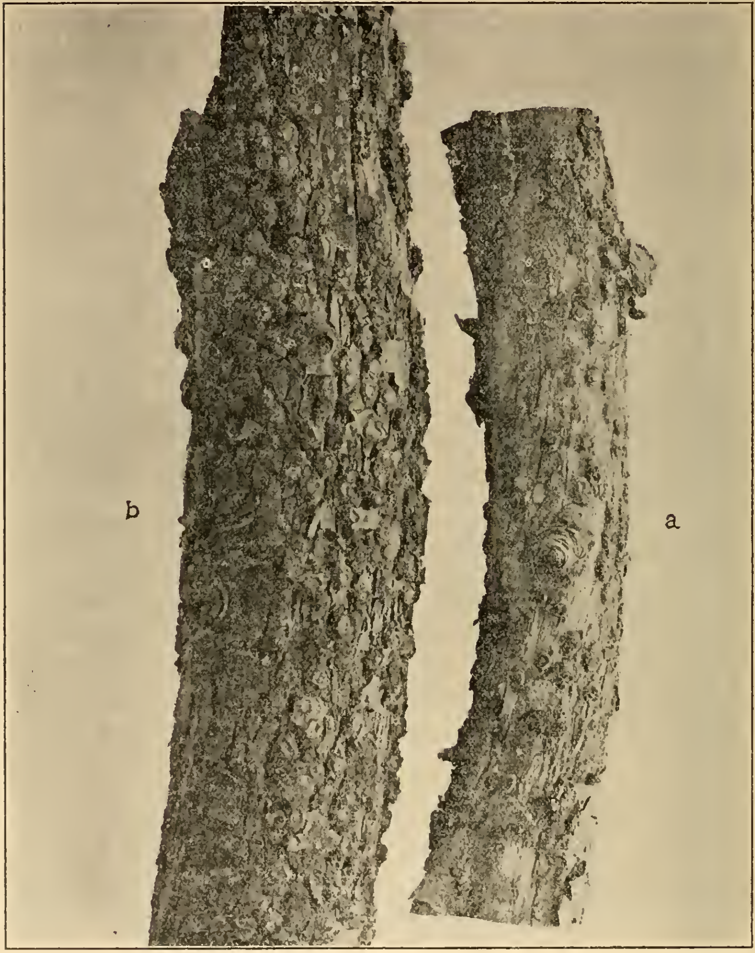

FIG. 4. Nummularia discreta. (a) The black stromata have been left on the apple branch after the bark has broken away. The stromatic rings on the wood show very distinctly. These characters are most prominent in a field diagnosis. (b) The bark has not yet broken away. In some places the outer epidermis still covers the stromata. This gives some idea of the relative abundance of stromata on the cankered portions. Some of the rings on the wood show on the fractured end of the branch.

in diameter. The stromatic tissue is hard and resistant and remains in place after the bark has broken away. This is one of the characters which makes the canker easy to recognize. This together with the rings which the discs leave on the wood after the stromata are broken loose, gives two characters which make it possible for anyone to determine it. Even to the untrained observer, these marks if once known, will lead to a proper diagnosis. (Fig 4, a and b).

In the Cook orchard, south of the Dairy building, this canker occurred in abundance. Nearly all of the trees were cankered to a greater or less extent. The large limbs were the ones usually attacked. Sometimes the canker was well down on the trunk of the tree on the lower side of the branches and extended far out on the branches and twigs. In such cases large limbs were entirely killed.

Nummularia appeared in the exposure on May 2nd, and again on May 9th. At the time when it began to appear small masses of spores could be seen at the necks of the perithecia on the stromata. It produces a loose cottony colony with a brownish tinge, especially on the under surface.

3. *Sphaeropsis malorum* Pk.

Sphaeropsis malorum is one of the most common fungi that inhabits pome-fruit orchards east of the Rocky Mountains. This is one of the forms whose pycnidia were found on twigs in the orchards at Heath's near College View, and south of the Dairy building. It is the cause of the "black rot" of the apple, pear, and quince, and produces cankers on the twigs of these trees. The small black pycnidia, just beneath the outer bark, characterize this fungus, which occurs so abundantly in nearly every orchard of this region.

Diseased twigs are perhaps the most abundant source of infection. Infection may also be due to diseased fruits of the previous year's crop.

Scott* has shown that it is the principal cause of leaf-spot of the apple, producing small brown patches. It is not commonly the case that the pycnidia are formed on the leaves until after they have fallen.

At various times during the year diseased twigs were brought into the laboratory and the fungus grown in planted plates. The upper surface of the colony is a dirty gray and the

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*Scott, l. c.

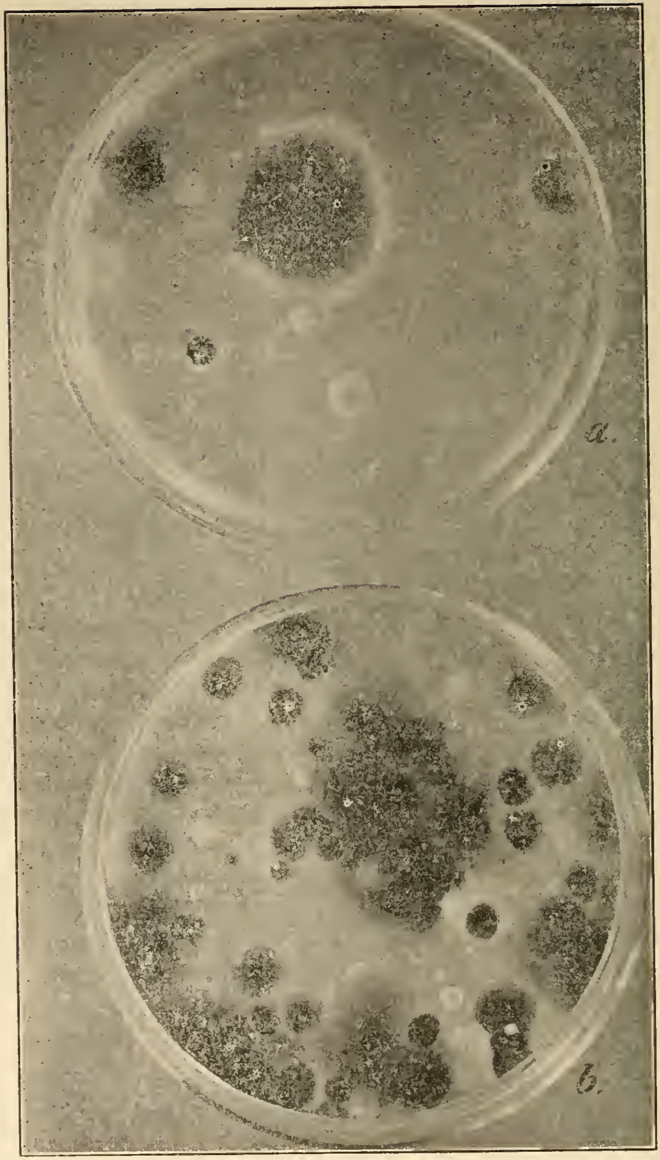

FIG. 5. (a) Exposure in "cared-for" orchards. (b) Exposure in neglected" orchard.

lower inky black, which is very characteristic of its cultural appearance. The pycnidia were also formed on naturally infected apples brought into the laboratory from the orchard and placed in damp-chambers.

The strange feature about Sphaeropsis is the fact that at no time did it appear in the trap cultures. Since it has been found to grow so luxuriantly in cultures, it is not because the spores are not viable. The only explanation for its absence is in the peculiar type of pycnidium, which has been found for *Sphaeropsis malorum.** This new form of Sphaeropsis has a closed pycnidium. The spores, too, are larger than the ones described for this species. A careful microscopic examination of spores taken from the pycnidia of some of the twigs showed that the spores were of the same size as those described for this new form. This would seem to indicate that there is a certain definite time when the pycnidia are open and the spores are capable of producing infections. This period does not occur, apparently, from September to June.

Paddock,† in his work on the "New York Apple-tree Canker," caused by *Sphaeropsis malorum*, says that infection usually takes place in the spring in the crevices of the bark. Growth stops in mid-summer and the spores are ripe by August. From this it would seem that the spores should have been obtained in the exposures. Since the form with the closed pycnidia is the most common here, the explanation of the absence of viable spores probably lies in this structural character.

EFFECT OF CLEAN CULTIVATION.

At first the exposures were from fifteen to twenty minutes duration. This time was limited, subsequently, until from one to two minutes was adopted as a sufficient time. This was found to yield just the same forms as longer exposures. In every case the plates were placed upon the ground. By so doing one might expect that the fungi which appeared would not be representative of existing conditions. Instead of coming from the trees, some might hold that the spores came from the ground cover. This is true only in part. One of the stations was chosen on a strip on which nothing was grown, yet it showed the same species and the same number of colonies in general. When the ground was covered with snow spores appeared in the trap cultures.

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*Walker: Annual Report Nebr. Exp. Station. 21:34-44. 1908.
†Paddock: Bulletin N. Y. Agricultural Exp. Station. 163:1-6. 1899.

A very notable fact, however, in regard to the influence of ground cover upon the number of spores in the air of the orchard, comes from two sets of exposures which were made at Hartley's orchard, the one on March 17th and the other April 6th.

Stations 1, 2, 3, and 4 were made in the old orchard, and 5, 6, 7, and 8 in the new orchard.

In the old orchard the weeds had been permitted to grow unmolested and the trees were badly in need of pruning. In the new orchard, the ground cover was a closely mowed sod, and the trees were in good condition. These two orchards might be taken as typical of the "cared for" and "neglected" orchards as found everywhere. By a comparison of the cultures from the orchards it can be seen that the number of fungi in the latter is very much greater than in the former. This represents a very interesting fact. Its significance to orchardists can not be over-emphasized. Where weeds, trash and rubbish are allowed to accumulate, a better harbor for fungi may be expected than where conditions are the reverse of these.

While it may be maintained that it represents conditions as they exist, only during the trees' inactivity, yet this is too significant to be lightly passed over. It would be only natural to expect that the greater the number of fungi when the tree begins its activity, the greater would be the chance of suffering from their attacks, or perhaps succumbing to them. We use sanitary measures to protect the health of the home. It is no less necessary if we would maintain healthy trees, that we establish sanitary conditions as regards orchards. Nothing could more forcibly point to the value of such care than the following tabulation:

OLD ORCHARD.

Station	Date	Weather conditions	Time	No. of fungus colonies	No. of yeast forms	No. of bacteria	Total
1	Mch. 17	cold, windy, partly cloudy.	1 min.	Phyllosticta... 8 Cladosporium . 12 Alternaria .... 6 Penicillium ... 7 Oospora...... 2 Unknown..... 1—32	17 white	0	49
2	"	"	"	Phyllosticta... 1 Cladosporium . 6 Alternaria .... 3 Penicillium ... 3 Unknown..... 4—17	19 white	0	36
3	"	"	"	Phyllosticta... 15 Cladosporium . 12 Alternaria .... 4 Unknown..... 1—32	5 white	2	39
4	"	"	"	Phyllosticta... 7 Cladosporium . 3 Alternaria .... 2 Unknown..... 4—16	1 red 7 white,8	0	24
NEW ORCHARD.							
5	"	"	"	Phyllosticta... 1	3 white	0	4
6	"	"	"	Oospora...... 2	2 white	0	4
7	"	"	"	Phyllosticta... 1 Cladosporium . 6 Alternaria .... 4 Penicillium ... 2—13	7 white	0	20
8	"	"	"	Aspergillus.... 1 Penicillium ... 4— 5	2 white	1	8

OLD ORCHARD.

Station	Date	Weather conditions	Time	No. of fungus colonies	No. of yeast forms	No. of bacteria	Total
1	Apr. 6	Warm, very calm, bright.	2 min.	Phyllosticta... 5 Cladosporium .33 Alternaria.... 6 Oospora...... 5 *Unknown... 1—50	6 red 35 white	2	93
4	"	"	"	Cladosporium . 8 Alternaria.... 4 Oospora......15 *Unknown... 4—31	red, 5 white175 180	17	228
NEW ORCHARD.							
5	"	"	"	Phyllosticta... 1 Cladosporium . 5 Alternaria.... 3 Oospora...... 2—11	red, 3 white, 20 —23	3	37
6	"	"	"	Phyllosticta... 3 Cladosporium . 7 Alternaria.... 4 Oospora...... 1—15	red, 2 white, 12 —14	1	30
7	"	"	"	Cladosporium . 1 Alternaria.... 3 Oospora...... 2— 6	red, 1 white, 12 —13	4	23
8	"	"	"	Phyllosticta... 1 Cladosporuim . 5 Alternaria.... 5 Oospora...... 2 *Unknown.... 1—14	white, 13	0	27

*No fruits were formed.

INFLUENCE OF CLIMATIC FACTORS.

The effect of the factors, rain, wind, and temperature, upon the presence of spores in the orchard, agrees with the experiments of Saito in his work upon the atmospheric spores of the garden. The effect of these factors is only secondary to the main purpose of this investigation because of their influence in determining atmospheric conditions. So this part of the work need only be a confirmation of facts already known, and explanatory of the presence or absence of particular forms at certain times.

Of these three factors, which control the presence of atmospheric spores, rain, snow, or precipitation of any sort, is the most important in decreasing the total number in the air at a given time. This can be accounted for in that those which are floating in the air will be washed to the ground, as will those which are adhering to the tree, or they may be held by the film of water which surrounds the twigs. That the air is freer from organisms after a rain than at any other time is a matter of common knowledge.

Wind has just the opposite tendency. Several investigators have found this to be true as a result of their work. One has shown the marked influence of air streams in the spread of spores.

Bernbeck* shows this very clearly in his work on the wind as a factor in plant diseases.

The factor which would seem to be of least influence as observed in this work is temperature. The following is a record of the temperatures for November, December, January, February and March:

No. of zero days		Minimum	Sum of zero degrees	Mean Temperature
November . . .	0	16° Fahr.	0	40.6° Fahr.
December . . .	0	5° "	0	31.4° "
January	0	4° "	0	31.0° "
February	2	−4° "	−4 on 1st −2 on 2nd	28.6° "
March	0	14° "	0	41.8° "

This record shows rather a mild winter. While low temperature does have a great influence upon some forms, yet all are not affected in the same manner. This has been shown in the fact that *Phyllosticta limitata* occurred during this whole period.

If an arrangement of these factors in the order of their importance could be made, it would be rain, wind, and temperature.

RESULTS AND CONCLUSIONS.

The following are the most important conclusions which may be drawn from the results of these glucose agar exposures in the orchards.

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*Bernbeck: Der Wind als Pflanzenpathologischer Faktor. (Diss. Bonn, 1907.)

1. The greater number of forms which are present in orchards during the autumn, winter, and spring are saprophytic, the most common being Alternaria sp., Cladosporium sp., and *Penicillium expansum.*

2. *Phyllosticta limitata*, a parasite, and a very common cause of leaf-spot of apples, is present in abundance during the entire winter period, regardless of temperature.

3. *Nummularia discreta*, although the fruits are mature, does not disseminate its spores until May.

4. At no time during the period in which exposures were made (September to May, inclusive) were viable spores of *Sphaeropsis malorum* present in the atmosphere of the orchard.

5. The total number of spores in the air of orchards is influenced by the ground cover, being less in well kept, and more in neglected orchards.

BOOKS AND CURRENT LITERATURE.

Marloth has recently published in the South African Journal of Science a study of "The Vegetation of the Southern Namib" which deals with an area approximately 50 miles wide, lying about 100 miles north of the Orange river, characterized as a "waterless desert" and presenting certain striking features of vegetation which can be definitely correlated with environmental factors. Among the most interesting cases may be mentioned the trimming effect of the wind. On the rocky hills small shrubs of Pteronia or Salsola are trained into a narrow, sharp-edged wedge, ten times as long as broad and closely pressed to the ground, the main stem being bent over at a right angle immediately above the projecting stone or pebble, behind which the plant had started its growth. This and additional vivid description given by the author call to mind the precisely similar phenomena which travelers by the Southern Pacific may observe in the northern part of the Colorado desert.

Hryniewiecki reports in a natural history publication of the University of Dorpat the results of his investigations of rheotropism of roots conducted in the botanical laboratory of Leipzig. It appears that rheotropism is most pronounced in all cases when distilled water is employed, and that the reaction is "paralyzed" when a 0.1% solution of a neutral, acid, or alkaline salt is added, while with a weaker concentration, say 0.01%, a distinct positive reaction follows. From these and numerous other experiments the author concludes that the curvature of roots in different media may be classified, at least in part, under the phenomena of chemotropism.

Junge, in a painstaking monograph of the "Cyperaceae of Schleswig-Holstein," classifies the 52 species there found under four heads as follows: (1) Species (45 in number) for which Schleswig-Holstein is considered the center of distribution. (2) Three species which have entered this region from the southwest or west. (3) One species which has entered from the north. (4) Three species from the east or southeast. One reason for the limited area of distribution of the species of groups 2 to 4, as compared with those of group 1, seems to be that their movements have taken place largely in a later period. Peculiarities of soil, especially of temperature and moisture, have also been potent factors.

Wolf's "Monograph of the Genus Potentilla" (Stuttgart, 1908) shows that the species of this genus occur chiefly from the Tropic of Cancer northward. In America its representatives are not found beyond Mexico, except two in Guatemala, another on the Andes in the northern part of South America, and *P. anserina*, which is capable of enduring transportation in salt water, and occurs as far south as the coasts of Chile and New Zealand. In Asia species of Potentilla are seldom found beyond the Sahara, and in Australia the genus is unknown. It is assumed from these and other facts that the genus originated in the temperate and colder regions of the northern hemisphere and has there attained its present development.

Wettstein records the occurrence in the Tirol of an annual form of *Ranunculus alpestris* which came true in cultures and appears to be a plain instance of an annual arising as a mutant from a perennial. Observations of the same author on *Soldanella pusilla* indicate the occurrence of mutation in nature of this species.

Warming's "Ecology of Plants" (Clarendon Press, 1909) presents various noteworthy departures from the author's original work of 1895, which was subsequently translated into German. Most noticeable is the extension of the original four groups characterized as hydrophytes, xerophytes, halophytes, and mesophytes, into thirteen, namely:

A. Soil very wet.
  1. *Hydrophytes* (water plants).
  2. *Helophytes* (marsh plants).
B. Soil physiologically dry.
  3. *Oxylopyhtes* (on sour soil).
  4. *Psychrophytes* (on cold soil).
  5. *Halophytes* (on saline soil).
C. Soil physically dry, climate of secondary importance.
  6. *Lithophytes* (on rocks).
  7. *Psammophytes* (on sand and gravel).
  8. *Chersophytes* (on waste land).
D. Climate dry, soil properties dominated by climate.
  9. *Eremophytes* (desert and steppe).
  10. *Psilophytes* (savannah).
  11. *Schlerophyllous* formations (bush and forest).
E. Soil physically or physiologically dry.
  12. *Coniferous* formations (forest).
F. Soil and climate favor mesophilus formations.
  13. *Mesophytes.*

The well-known "Physiologische Pflanzen Anatomie" of Haberlandt has passed into its fourth edition. (Engelmann, Leipzig, 1909.)

From Professor J. M. McFarlane's study of the Nepenthaceae contributed to Engler's "Pflanzenreich," it appears that these plants are limited almost exclusively to the monsoon region of the East Indies with their main center in northern Borneo. *N. madagascarensis* has extended farthest from this center and *N. phyllamphora* has the widest area of distribution, extending from southeast China through Sumatra and Borneo into New Guinea. In the related family, Sarraceniaceae, also elaborated by Dr. McFarlane for the "Pflanzenreich," there are three genera, Heliamphora, found only in a limited area between British Guiana and Venezuela, Darlingtonia, with its distributional center in northern California and southern Oregon, and Sarracenia, with its original center in the eastern gulf states.

Reinders, in a paper on "Sap-raising forces in Living Wood" communicated to the Royal Academy at Amsterdam, relates several experiments which show that living wood is able to pump water actively. He demonstrates this by means of several manometers placed on different branches in the same tree. While the wood was living all showed irregularities, but when the wood below any manometer was killed the pressure at once became regular. The fact that killing the wood removes irregularities of pressure he regards as a proof that living wood has a hydromotory power.

Marloth, in a paper on "Some New South African Succulents," announces the finding of five new species of succulents (four of Mesembrianthemum and one of Haworthia) having window leaves, *i. e.* stemless succulents, whose egg-shaped leaves are imbedded in the ground with only the apex visible. Here the green tissue is absent, being confined to the sides of the leaf. As the sides are surrounded by soil, the light reaches only by entering the window through the apex, thus illuminating the leaf from within.

Prof. John H. Schaffner has recently published a second edition of his "Laboratory Outlines for General Botany." Additions have been made to the first edition to bring the outlines up to date and give a more perfect view of the plant kingdom as a whole from the standpoint of evolution. They are intended for the use of college students of the freshman or sophomore year, and are planned to occupy six hours laboratory work per week for one year. Something like 90 types are outlined besides a considerable amount of anatomy of Pteridophytes and Spermatophytes, a number of forms to represent the general evolution of the flower, karoykinesis, and an appendix on general methods of microtechnique.

It is plain the teacher must choose at the outset whether the pupil shall prolong the course beyond one year or go quickly through all this material and get a very general view of the whole field of botany. The second alternative is evidently the one approved and used by Prof. Schaffner, and when supplemented by lectures, such a course as he has outlined will without doubt leave the student with a fairly comprehensive view of plant relationship. It should also leave him with a profound sense that what he has accomplished is only a beginning. For this, the teacher must in great measure be responsible. The Outlines seem to be a very successful attempt to furnish practical directions which can be utilized by the student at first hand.

"Our Garden Flowers" is the title of a new and interesting book on the commoner garden plants, from the press of Scribner's Sons. The book has five hundred and fifty pages, including an index and brief glossary and costs $2.00. The press work throughout is excellent, and the book is well illustrated. It treats of plant varieties adapted for growing in the eastern half of the United States. The author of the work certainly has a rare acquaintance with plants and has shown herself to be a close observer of them. This work will prove valuable not only to the florist and amateur gardener, but to all others interested in flowers. It is deserving of a large sale, which it will undoubtedly have. To read it is to become interested in the subject of flowers.

It contains an excellent index of the common and scientific names of the plants of the numerous families, and in the treatment of its species a brief popular description is given after which the nativity, history and the more important features of the plant are touched upon in a very entertaining manner. It is to be hoped that the author will prepare a similar work for the plants of the western half of our country.

In the reviewer's opinion such plants as the parsnip, horse radish, spinach, field turnips, black and white mustard and cultivated beets, might well have been excluded, since they are plants but not flowers, or else the title of the book should have been changed to read "Our Garden Plants."

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THE MAKING OF PARASITES.

BY D. T. MACDOUGAL.

About 2,500 species of parasitic seed-plants are known, which are included in two hundred genera, representing ten great families. Thorough examination of the roots of the common plants would doubtless result in evidence that would double the number of known parasites, and give a total that would include about five per cent of all flowering plants, which exhibit dependent nutritive habits.

Any study of parasitic plants leads to a consideration of the mycorrhizal forms, or plants which form associations with filamentous fungi in which the thread-like hyphae enwrap or penetrate the roots of the higher plants. Such partnerships generally result in some advantage to the higher plant, and are followed by immediate changes similar to those exhibited by species known as parasites. These changes include a lack of differentiation of the tissues, even in the seed and embryo; a lessened development of the shoot and root, a reduction of the leaf surface and diminished production of chlorophyll. Taken together, the parasitic plants and those which enter into partnerships with fungi in the soil, comprise nearly half of the seed-plants of the world. It is evident that the existence of a tendency of the kind indicated affecting half of the higher plants, which leads toward atrophy of the vegetative organs and the development of specializations of structure and habit seen in associations and dependent nutrition, must have a tremendous significance for the student of evolution.

Singularly enough, the modifications exhibited by parasites are not due directly or alone to the food received from the host or symbiont, a similar effects are not seen when plants are fed with solutions of organic materials which might be obtained by parasitism. The entire set of complicated conditions furnished by active association with a living host or co-operating organism seems to be necessary to induce the changes described.

The studies of the general anatomical features presented by the families, the members of which exhibit parasitism,have so far failed to yield any conclusions as to the morphological features which might be favorable to such arrangements. The specialization of tissue which ensues when a seed-plant becomes parasitic fortuitously is far more striking than any simple anatomical character which might be interpreted to indicate a predisposition to the dependent habit of nutrition in autophytes.

The mechanical adhesion of the bodies of seed-plants which would make parasitism possible, might be brought about in three different ways. The roots growing thickly interlaced in the soil might unite or penetrate each other, or adventitious roots arising from internodes at any place on the aerial stems might pierce the bodies of other plants, or seeds lodging in the bark or in the wounds of a plant, might germinate and send absorbing organs into the tissues of the possible host. Of these methods, that of incidental root-parasitism seems to bear the greater probability of occurrence, and to be illustrated by some very striking examples. Pee-Laby has recently described a case in which the main root of a plant of a passion-flower vine (*Passiflora coerulea*)had become attached to a root of Japanese burning bush (*Enonymus japonicus*) forming a specialized absorptive tissue, and undergoing general atrophy of its own root-system, in a manner suggestive of a highly developed degree of parasitism, although but little indication of this was to be seen in the shoot of the Passiflora (Rev. Gen. d. Bot. 16: 453. 1904.).

The germination of seeds on the bodies of other plants might result in mechanical parasitism, the advantage being purely one of position with respect to light, and this is illustrated by many hundreds of examples particularly abundant in tropical forests. The development of any form of nutritive dependence out of such purely mechanical relations has not yet been demonstrated although various workers, notably Peirce, have made extensive demonstrations of the possibility of short-lived annuals, completing their entire cycle of existence as parasites upon enforced hosts, in the tissues of which their seeds were germinated, or were set at an early stage of their existence.

Grape culturists in France sometimes insert seeds of the vine in old living stems of the same plant a short distance above the ground,and its results that the developing plantlets send roots through the tissues which eventually reach the soil and ramify in it. Many of the phenomena consequent upon grafting operations also are of interest in this connection. Such unions may be of all degrees of intimacy, varying from perfect grafts where the vessels unite, to other cases in which the cion is separated from the stock by a layer of dead tissue, through which there can be no free interchange of material as between a branch and a main stem, but instead, a phase of parasitism exists. These arrangements, in fact, present the simplest accomplishments of parasitism artificially produced.

A large number of instances are known in which the cion after uniting with the stock, or during the process, sends out adventitious roots, which strike downward and penetrate the tissues of the host, simulating parasitism mechanically, as would be done whenever the roots of any plant accidentally bore through those of another. No real or important transfer of food material has been demonstrated in such cases, and the roots showed no prolonged existence.

In the organization of an experimental analysis of the conditions of parasitism, at the Desert Laboratory, it was thought advantageous to use plants furnished with a large water- balance, and hence capable of existence for extended periods, independent of any additional supplies. Such forms have great inertia, that is, cuttings or sections of the body may carry on existence in a fairly normal manner for a long time, without additional supplies, and during this time, regeneration and the formation of new absorbing organs may take place with adjustment to conditions of parasitism. Observations of material of this character might well furnish exceptional opportunities for detecting the conjunction of conditions, or developing stages which would facilitate the assumption of dependent relations in nutrition. The use of massive plants also rendered it easy to make the chemical analyses necessary to determine the concentration of the cell-sap, which was thought to be of importance in this connection. The most direct method of ascertaining the relative osmotic value of the sap of two plants would be by freezing tests of the expressed juice.

The native flora around the Desert Laboratory at Tucson, Arizona, is rich in succulents which furnish the conditions noted above, and the material chosen for experimentation in the present work included chiefly several opuntias which were used as both host and parasite, normal and in etiolated condition, *Carnegiea gigantea*, exclusively as host, *Echinocactus wislizeni* as host, *Fouquieria splendens* as both host and parasite, *Cissus digitata* and *C. lacinata* from southern Mexico, *Agave americana*, *Cotyledon macrantha*, and *Tradescantia* as parasites, in addition to a number of other forms of which but slight use was made. After some preliminary tests, the arrangement of the material in the dependent relation, was begun seriously in January, 1908, and many hundreds of preparations have since been set up.

The methods of experimentation employed consisted in making cuttings of the joints of prickly pears, Mexican grape vine, agave and of other plants which were to be induced to live parasitically and thrusting these into a bed of sand until the raw surfaces were healed and regeneration with root formation had begun. Next, a suitable cavity was cleanly cut in the flesh of a giant cactus, or barrel cactus, or in the plant to be used as a host, into which the base of the slip of "xeno-parasite" was thrust. The insertion was held in place by an adequate setting of plaster of Paris, and the whole preparation was cared for as to shade and temperatures. If the inserted slip was capable of immediate adjustment to the new conditions, interesting results followed. The transfer of a plant from its original state to the experimental arrangement described, however, is an extremely radical one, and involves serious disturbances of a group of functions.

Thus, in the insertion of slips of one plant in the body of another, the development of the roots would necessarily be carried on in confined cavities, in which the only free oxygen available from the growth of these organs would be that coming from the intercellular spaces of the host and by transfusion. The lack of this substance alone would operate to prevent parasitism, while in other cases, the speedy formation of oxidases and peroxidases in the wood tissues, together with the ready formation of corky layers and mucus, would hinder root formation. None of these factors would be detrimental to actual grafting, since in this case the union of living cells and the intermediate tissues would proceed best when free aeration was prevented.

Some of these experimentally arranged parasites have endured for more than two whole seasons, forming roots which penetrated the soft bodies of the hosts in some instances, while other species absorbed juices directly through the epidermal surfaces of the healed bases of the slips inserted.

The spread and surface of leaves and branches developed from the inserted parasitic slips were, in all cases, less than that of similar parts which still formed a part of the original plant from which cuttings were made. The atrophies or reductions characteristic of parasites were thus seen as a direct response of the individual to dependent nutrition,foreshadowing the degradation or atrophy which reaches advanced stages in species which have followed a long course of parasitism.

After a great number of experimental trials had been made, in which the failures proved no less interesting than the successes, a series of analyses were made to determine the concentration or osmotic activity of the sap of the species used in the tests.

The results of these analyses and of the general observations show that the Mexican grape vine with an osmotic activity of 12 atmospheres was successfully parasitic on a small prickly pear (*Opuntia blakeana*) in which the mucilaginous juice had a pressure of 9 atmospheres, and on the barrel cactus (*Echinocactus*) at a pressure of 6 atmospheres, but not on the giant tree cactus (*Carnegiea gigantea*) at 7 atmospheres by reason of the copious gummy exudation and fermentation products which follow wounds in making the necessary incision in the body of the host. Rooted joints of the prickly pear were parasitic on the barrel cactus (see above), especially when the slender cylindrical joints produced by the prickly pear grown in darkness were used as parasites. The cylindrical prickly pear (*Opuntia versicolor*) with a juice showing a pressure of 12 atmospheres was successfully parasitic on Carnegiea, and on Echinocactus. Rooted cuttings of agave, or the common century plant, maintained themselves for extended periods upon Carnegiea and Opuntia, as it had a pressure of about 11 atmospheres.

A careful consideration of all the detail gathered from the experiments showed that one plant might become parasitic upon another only when it possessed a sap having a higher osmotic activity, and hence being capable of withdrawing sap from the body of the possible host. Other causes might intervene to prohibit parasitism even when the relative osmotic pressures were favorable, but such inequality was a necessity in all cases. It is to be noted that the pressure of the sap changes unequally in different species with the seasons and that a plant which might have a higher osmotic pressure at one season would be incapable of acting as a parasite during other seasons, with respect to any given host. The plants used in the tests were natives of arid areas and accumulate a relatively great amount of surplus water at times, thus lowering the osmotic activity of the sap, while during the drier seasons water is lost in such quantity as to increase the osmotic pressure. In none of the analyses of desert plants hitherto made, has the sap been found to show a higher activity than that of the common lilac and other plants which have been found by Dixon to display an activity equivalent to 25 atmospheres and even higher. It is to be noted also that many plants show a capacity for automatically increasing the osmotic activity of the sap when the solution in the sub-stratum becomes more concentrated, and this may play a very important part in the origination and development of parasites.

The relative acidity of the sap of two plants appeared to be of no importance in the determination of their capacity to enter into parasitic relations, quite contrary to a common supposition. The ready formation of wound tissue, or the exudation of enzymatic products, would act as a deterrent to a possible parasite, while the capacity for formation of adventitious, or of absorptive organs from the surface of stems would be an opposing factor in the development of parasitic relations. The more important features of the specialization by which parasitism ensues may thus be put in the form of an algebraic equation, the reduction of which should indicate with some certainty the possibility of dependent nutrition between two plants.

The unceasing distributional movements of species over the face of the world would undoubtedly operate to bring new pairs of species constantly under test conditions, and it is in accord with the known facts to suppose that new parasitic unions are being formed frequently in almost all kinds of habitats, while, on the other hand it is to be kept in mind that extinction lies beyond parasitism, as the inevitable atrophies which follow dependent nutrition must in the end bring the species to a precarious condition in which the slightest untoward variation in its highly complicated environment would end its existence.

The changes ensuing when a plant becomes parasitic may include some startling phenomena, as was illustrated by the action of the prickly pear used in the experiments. The structure of the heavy, succulent, jointed stems of the prickly pears present no features which suggest movement, yet when etiolated cylindrical branches of these plants a few inches long were inserted in the fleshy bodies of the barrel cacti, and had become well established, sweeping nutatory movements like those of a vine were set up which carried the tips through an arc of 180 degrees in 36 hours, the complete nutation occupying twice that length of time. Furthermore, these movements differed from other nutatory movements hitherto described by the fact that they were not accompanied by growth in length. So far as could be determined, the curvatures resulted from rhythmical alterations in the turgidity or osmotic activity of the cell-sap on opposite sides of the thin stems, thus setting up a movement utterly foreign to the ordinary habits of the plant, and purposeless so far as its environmental relations were concerned.

The results of this and previous studies allow us to recognize the limiting factors, the operative conditions, and some of the facts as to the physiological nature of parasitism. Few specializations present their main features so clearly to the student. When the total body of evidence, however, is evaluated in the light of current theories, it is found that it is no easy matter to decide by what main methods of evolutionary procedure this adjustment or "adaptation" is attained, and how it is advanced from stage to stage.

Some alterations such as that of Passiflora on Euonymous are distinctly discontinuous, but in this particular instance it cannot be shown that any permanent results would follow the occurrence of the dependent relation. Some features, however, such as the development of haustoria, on roots and stems, would be a distinct mutation, and is well illustrated by Krameria,and supposedly also by Cuscuta. The taking on of absorptive functions by the epidermal cells of xeno-parasites as described in the present paper, is to be recognized as a distinct nutatory alteration.

A direct and immediate atrophy of the various organs of the shoot ensues as a result of the assumption of the parasitic relation, but the extreme stages of such reduction appear to have been reached by gradual changes although it is evident that such a conclusion is almost wholly inferential. The transition from autophytism to complete parasitism with attendant habital characters, appears to have been gradual, since species may be cited to illustrate all degrees of the alteration, but, on the other hand, it is not impossible that the complete change may have been made at once in some forms. Nothing in the entire matter suggests progression or retrogression of all of the involved characters by one method alone.

Placing a plant in a dependent nutritive relation affects the organs concerned in nutrition and transpiration, and the changes which ensue may be connected more or less directly with obvious causes. In addition, however, modifications resulting from correlations are to be seen, while still other phenomena are to be noted which are wholly incidental and may not be connected in any purposeful manner with the existence of the plant. It is indeed quite to be expected when a plant which has lived thousands of years as an independent organism, is suddenly placed under dependent conditions with respect to another organism that it should display useless and aberrant qualities and structures, some of which may be of a very striking character.

SUGGESTIONS AS TO THE ORIGIN OF CALIFORNIA'S LICHEN FLORA.

BY ALBERT C. HERRE.

Even a cursory examination of Tuckerman's monumental works on North American lichens gives one the impression that the lichen flora of California is very remarkable. A study of California lichens in field and laboratory for the past nine years has heightened this impression and convinced me that it is unusual in several respects.

In the first place, we find in California a considerable number of lichens characteristic of other regions, but occurring rarely or not at all in other parts of the United States, while, as a contrast to this, certain species which are abundant almost everywhere else in our country are here conspicuous by their absence. Lastly we have here an extraordinary number of lichens found nowhere else.

As examples of lichens common to the Pacific coast and other parts of the world, but not found in the rest of the United States, we may cite from among many the following: *Cyphelium inquinans*, *Calicium hyperellum*, *Arthopyrenia halodytes*, *Microthelia metzleri*, *Opegrapha saxicola*, *Cetraria chlorophylla*, *Lecidea quernea*, *Lecidea caulescens*, *Lecidea intumescens*, *Lecidea aromatica*, *Gyrophora polyrrhiza*, *Leptogium palmatum*, *Polychidium albociliatum*, *Rinodina conradi*, *Pertusaria amara*, and many other European forms; *Buellia halonia*, a Cape of Good Hope species; three species of *Roccella*, *fuciformis*, *tinctoria*, and *fucoides*, all occur on the coast of California and are widely distributed over the warmer maritime regions of the earth, but are unknown to the Gulf or South Atlantic states. *Dirina*, a maritime genus represented in Europe and on the warmer coasts generally, does not occur along the shores of the eastern states, though represented in California by three endemic species. Then there are other lichens which are widely distributed in the Old world, yet occur to a very limited extent over most of the United States, though reaching great size and fruiting luxuriantly in California; as an example of such we may name *Letharia vulpina*.

Among the most widely distributed of lichens are the three closely allied species of *Cladonia*, *rangiferina*, *alpestris*, and *sylvatica*, and in parts of California the conditions are favorable for their presence, yet no specimens have yet been discovered there. I have indeed seen one specimen of *Cladonia rangiferina* collected at Seattle, the only Pacific coast locality known to me south of Vancouver.

The genus *Graphis* is represented in most temperate regions by the very common species, *Graphis scripta*, while *Graphis elegans* is also widely distributed over the eastern United States; yet neither these nor any other species of *Graphis* is known from California, whereas by analogy one would expect a number of species out of the 400 known. The only representative of the group known is the closely related genus *Phaeographis*, represented by the species *inusta*, and it is excessively rare in California.

Why these *Cladonias* and *Graphis* should be absent I can by no means explain, but the presence of lichens common to California and Europe, but not occurring between, can perhaps be explained. The lichens common to Europe and California occur either along the sea coast of California or in the mountains, in regions where the average mean temperature for the warmest months does not exceed 60 degrees Fahrenheit, thus approximating more nearly the life conditions of Europe than do the eastern United States, which have a much higher average summer temperature than the cold and humid regions of Europe lying far to the northward. The humidity of California is for the most part low, but this arid condition is in part compensated by the low average temperature for the summer months, though lying in the same latitude as the eastern states. This cool temperate climate characteristic of California I have elsewhere discussed more fully, and I believe it the most important factor in the determination of the distribution of the species mentioned.

No other region in the United States has so large a number of lichens which occur nowhere else, so far as known, as has California. Without entering into particulars we may safely place this number at not less than 100; Tuckerman alone described some 65 new species from California; Nylander, Stizenberger, and Zahlbruckner together somewhere between 60 and 75, while various other authors, including the writer, have described some 20 or 25 additional species. A considerable number of these including some of the most remarkable, such as *Ramalina reticulata*, extend northward as far as Vancouver, while there is no question that a more extended knowledge of the western lichen flora will show that perhaps half of the great number described from California also occur in some part of the adjacent states. But at present at least 100 have not yet been collected beyond the confines of the state.

Among these remarkable forms we may mention *Dendrographa leucophaea*, and *minor*, *Ramalina menziesii*, *Schizopelte californica*, *Caloplaca coralloides*, *Lecanora phryganitis*, *Cyphelium bolanderi*, *Hassea bacillosa*, *Aneptychia erinacia*, *Heterocarpon ochroleucum*, *Buellia oidalea*, *Platygrapha hypothallina*, *Schismatomma pluriloculare*, and a host of xerophytic *Acarosporas*, *Endocarpons*, *Heppias*, and the like.

At least some of the reasons for the remarkable character of California's lichen flora may be considered fairly certain. Among these we are safe in placing the very equable climate, the long dry season from April to October or November, and California's geographic isolation. It is true that California extends over more than nine degrees of latitude, but this has less effect on the character of her lichens than would be supposed. It is likewise true that California has the most varied topography of any state in the union, the highest peak and the deepest valley, but except on the very highest mountains or in the most barren depths there is relatively but slight variation. The aridity and scant rainfall of most of California south of Pt. Reyes, and the fact that the rain falls only during a few months of the winter, of itself tends to give a strongly xerophytic cast to the general flora, a tendency just as strongly evidenced in the lichen flora as well.

By California's geographic isolation I mean her separation from the rest of the country eastward by the enormous and towering Sierra Nevada range, beyond which stretches for hundreds of leagues an elevated, arid waste or desert plateau, on which for a thousand miles the common lichens of the humid east find little or no lodgment. In southern and southeastern California this desert extends well toward the Pacific, though no longer elevated but indeed passing below sea level, and includes such notorious regions as Death Valley, the Mojave, and the Colorado deserts. About the western borders of this region have been discovered a large number of lichens adapted to these very arid conditions and many of them are spread northward throughout a large part of the state. Undoubtedly further investigation in western Nevada and Arizona will reveal that many of these species are scattered all over the interior Basin and the valley of the Colorado, but beyond these regions they will hardly be found.

Along the more elevated peaks of the Sierras, especially in the Yosemite region, also occur a number of lichens not known elsewhere, but there is no question in my mind but that all or nearly all of them will be found on the highest ranges of Nevada and Oregon, if not elsewhere in the west.

Passing to the coast, we find on the rocky cliffs, bathed by the chill waters of the Pacific, and in the forests and foothills of the Coast Range, California's most conspicuous, characteristic, and unique lichens. The climatic conditions of this region, sufficiently set forth in a former paper on lichen distribution in the Santa Cruz peninsula, are evidently highly favorable to a luxuriant or unusual growth of lichens which elsewhere are not of such rankness or high stage of development.

Though sexual processes in the life history of most lichens are a doubtful if not indeed a minus quantity, it still seems evident to me that the combination of geographic isolation, together with an equable climate, accompanied by peculiar moisture and growth conditions, has been the agent which has effected the evolution of such an unusual number of endemic species. That they have undergone many marked evolutionary phases all will agree, and in fact the phylogeny of several families is pretty well worked out, while no one can study the Cladonias for long without assenting to the proposition that here we have a group of lichens still in an unstable stage of evolutionary development.

It will perhaps be impossible to work out satisfactorily all the factors in the evolution of such composite organisms as lichens, a composite of alga and fungus, without the sexual methods of breeding upon which most organisms depend. Here there are apparently no Mendelian factors, no karyokinetic problems, no mutation or germinal selection, no germ plasm to receive stimuli or transmit acquired characters. We have as means of reproduction only a sexually produced fungus spores which germinate mayhap in the presence of the proper algae, or else bits of the thallus (soredia) blown about to start new lichens when the conditions are right. Yet, in spite of all this there is real evolution among them, and they do have a real heredity, else there could be no definite species.

Lichens are among the most variable of all organisms and are also among the most widely distributed. Their inherent variability causes them to develop a great variety of forms which intergrade in a multitude of ways. But this inherent variability in the case of individuals containing material from a single parent only, as in lichens as a whole, seems to give rise to few or no new species when the factors of the environment over large areas are relatively unchanging. Hence the comparatively fewer number of unique endemic species in the eastern United States and this in spite of the fact that there seems to be no definite or fixed limits to the variability of lichens. The relative uniformity of environment seems to be sufficient to retain the same mean average of development, to restrict the species within certain definite limits.

It follows, therefore, that when these organisms are sufficiently isolated and placed under conditions different from those obtaining in most regions, they are prevented from retaining the same mean average established in regions where there is no isolation. I believe that the isolated lichens, which are inherently exceedingly variable organisms, have this variability controlled by a kind of orthoselection, which thus works unimpeded until new species are produced. These new species may become fixed, under the influence of their new environment, in the lapse of ages, or they may be as yet unstable, perhaps not having had sufficient time to become completely fixed.

As examples of fixed species developed under the influences suggested in this paper, we may cite *Caloplaca coralloides*, *Schizopelte californica*, *Ramalina reticulata*, and *Lecanora pinguis*. On the other hand we may regard the following quite variable forms as not yet firmly fixed: *Lecanora bolanderi*, *Dendrographa* *leucophaea* and *Dendographa minor*, *Platygrapha hypothallina*, and *Bacidia herrei*, which seems to be in process of developing into two species, one a bark dweller and the other living on sandstone.

THE POROUS CLAY CUP FOR THE AUTOMATIC WATERING OF PLANTS.

BY LON A. HAWKINS.

The advantages of a method whereby the moisture supply of a potted plant may automatically be kept approximately uniform during long periods of time are obvious to all who have to grow plants in pots for any purpose. If the daily attention necessary to maintain adequate soil moisture for pot-grown plants may be obviated without producing any undesirable effect upon growth, the method by which this is possible should be very valuable. The best method so far described seems to be that of Livingston, which he exhibited at the Chicago meeting of the American Association for the Advancement of Science, * and the present experiments have been carried out with the view of obtaining a better knowledge of this method. The plants were grown in common garden soil, the cups used were the same as those used by Livingston, and the method of setting up was similar to that recommended by him. Three plants of Coleus were grown in the self-watered pot for 180 days, and plants of Vicia faba were grown from the seed to the late flowering stage.

In the experiment with Coleus, three healthy, pot-grown plants were equally spaced around the porous cup, the latter being placed in the center of an 8-inch pot of the usual form, with the top of the cup level with the rim of the pot. The soil was filled in to within a centimeter of the rim. The soil surface was covered, to prevent evaporation, with composite modeling clay, and the exterior of the pot was coated with paraffin. Thus, practically no exchange of gases between the interior of the pot and the outside could take place, excepting through the water of the tube and cup and through the plants themselves. The cup was filled with water and closed with a rubber stopper bearing a bent glass tube, this in turn being connected with the water reservoir by means of rubber tubing. The cup was filled while the reservoir was at a higher level, a stream of water flowing through the tube at the time of the insertion of the stopper. The reservoir was placed at various levels below the pot and weights of the latter with the plants were taken at intervals until it was found that with a water column of 50 cm. the fluctuations in weight were very slight. Then the reservoir was allowed to remain so that when filled the water surface therein was 50 cm. below the bottom of the pot. The arrangement is shown in Fig. 1.

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*Livingston, B. E., A method for controlling plant moisture. Plant World, 11: 39-40. 1908

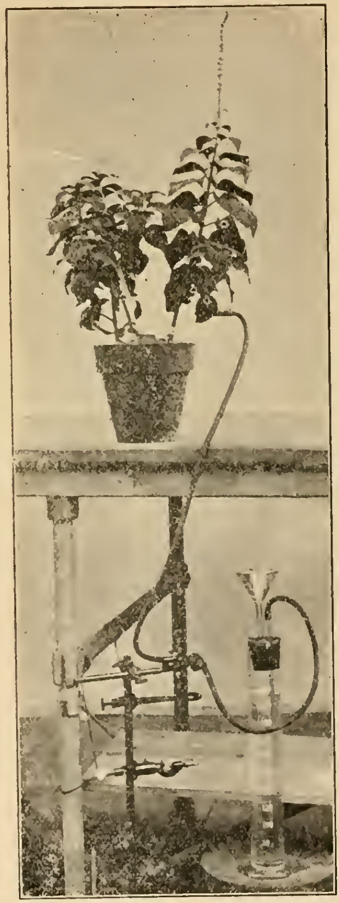
Figure 1.

This experiment began Nov. 19, 1909, and the plants were under observation till May 18, throughout a period of 180 days. During this time they received no water excepting through the cup. During the first ten days, with the reservoir but ten centimeters below the pot, 395 cc. of water were removed from the reservoir by the automatic apparatus, and the weight of pot and plants showed an increase of 165 g. Thus about 230 g. had been lost, mainly by transpiration. On April 13, after 145 days, the weight showed a loss of 20 g. since the beginning, although the plants had grown considerably. This indicates that the soil was slightly drier at this date than at the start. During this period several records were lost, and it is impossible to state just what was the total amount of absorption. By interpolation it is estimated to have been about 5,500 cc. for the period of 145 days. During the last 35 days the absorption amounted to 520 cc., giving a round total of something like 6,000 cc. for the 180 days.

The modeling clay was rolled back once, for four days, after the experiment had been in operation for two weeks, after this it was replaced and allowed to remain until the end. The cup had to be refilled twice, once when the reservoir had been allowed to become empty and again when the graduate, used as a reservoir, had been accidentally broken.

The plants grew rapidly, better than those watered in the usual way. Two of them showed an increase in height of 62 and 59 cm. respectively. The original height was 14 cm. in each of these two cases. One plant had been in bloom 69 days, the second, 57 days, at the end of the experiment. A few flowers could still be seen on May 18. The third plant had lost its primary growing point and had three branches. One of these elongated, in 145 days, from 15 cm. to 28 cm. in length. None of the branches of this plant had yet bloomed at the end of the experiment. The appearance of the culture at the end of 104 days is shown in Fig. 1.

The excellent growth made by these plants, under conditions which cut off the usual supply of air to the soil, seems remarkable in the face of what is usually held in this connection. But with such meagre data at hand, it is sufficient to state here that they grew vigorously for 161 days without other appreciable supply of oxygen to the roots than by way of the water in tube and cup and by way of the aerial parts of the plants. The plants were watered through the cup for 180 days, and were apparently as healthy at the end of that time as at the beginning. Two of them had nearly completed their life cycle and were practically at the end of the period of blooming on May 18.

In the experiments with *Vicia faba*, five 6-inch pots were used, four of these being supplied with the automatic watering device, and the fifth being left in the gardener's care and watered daily in the ordinary way. Pot 1 was completely sealed, as in the experiment with Coleus; pot II was paraffined but the soil surface was not covered; pot III was sealed over the soil surface with modeling clay but was not paraffined; pot IV was left unsealed.

Pot V constituted the control, without automatic watering apparatus.

The cups in the first four pots were connected by means of a small lead tube to separate glass bottles of one liter capacity. At each observation the bottles were filled to a file mark on the narrow neck, record being made of the amount of water necessary for filling. The reservoirs were so placed that the water surface when they were filled, was 40 cm. below the base of the corresponding pot.

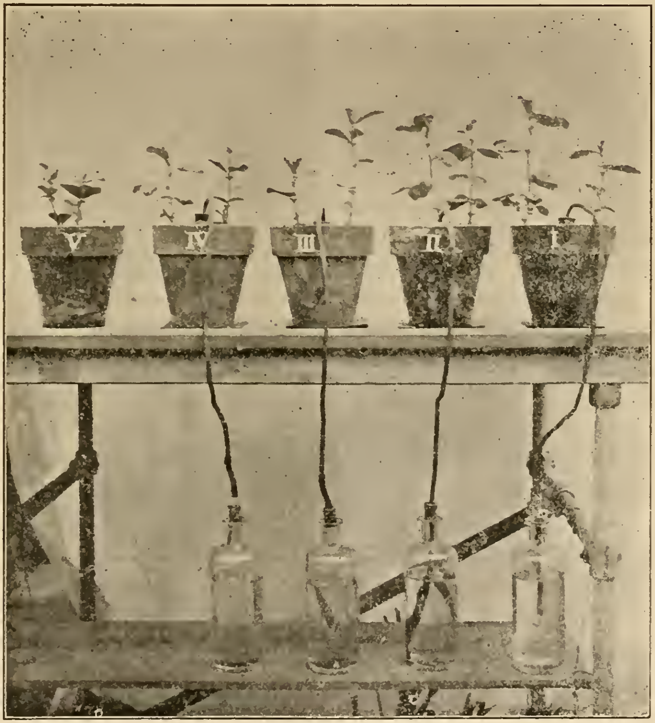

Figure 2.

Four soaked seeds were planted in each pot on Feb. 2, 1910, A considerable variation in the time requirement for germination could not be directly related to the conditions of soil moisture, neither could the failure of several seeds to germinate be related to any external condition, and so, on Feb. 23 (20 days after planting), the seedlings were rearranged so as to leave two in each pot. To accomplish this it was only necessary to remove two seedlings from pot I and to plant one of these in each of pots III and IV. The seedlings in the self-watered pots were as nearly uniform as possible, each pot having a smaller and a larger one. Those in the control pot were at this time considerably smaller than any others, due to delay in germination which was very pronounced in this pot. At the time of rearranging, the total absorption by the self-watered pots, for

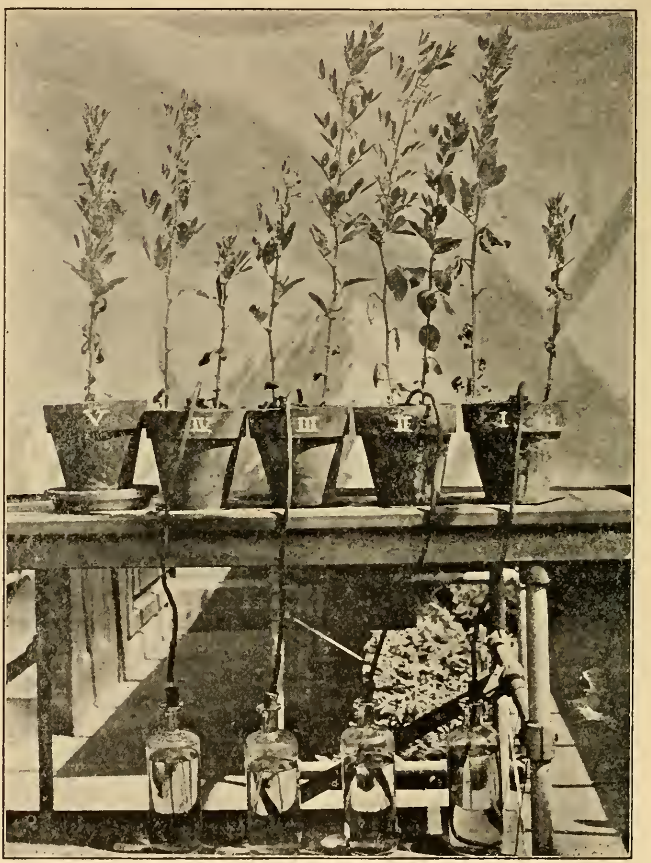

Figure 3.

20 days, had been 654, 785, 1133 and 993 cc. in the numerical order of the pots.

Beginning Feb. 23, a record was kept of the absorption of each of the first four pots, and also of the growth in height, etc., of all five cultures. The condition of the plants on March 4, 9 days after rearranging, is shown in Fig. 2. On March 23, after 28 days, all plants were in bloom, the inflorescences of cultures III and IV being in advance of the others. Five days later, March 28, note was made of the fact that the oldest leaf was withering on each plant in pots I and II, the two lowest leaves were withering in pots III and V, and the three lowest leaves were dead in pot IV. At the end of the experiment (April 13 after 49 days) the plants ranked, in condition and appearance, as follows: those in cultures II and III first and best, those in I and IV second, and those in control (V) last. Flowering had progressed very far in II and III ,not as far in I and IV, and had only well started in V.

The appearance of the cultures at the end of the experiment is shown in Fig. 3. The measurements of growth and of the absorption of water for the 28 days before flowering and for the 21 days thereafter are presented in Table I. In this table "abs" denotes the amount of water absorbed, "gr'th" denotes growth, and the two plants in each culture are designated by the letters

TABLE I.

WATER ABSORPTION AND GROWTH OF VICIA FABA.

Experiment begun Feb. 23, 1910.

DATE AND PERIOD	POT I			POT II			POT III			POT IV			POT V	
	Abs.	Gr'th cm.		Abs.	Gr'th cm.		Abs.	Gr'th cm.		Abs.	Gr'th cm.		Growth cm.	
	cc.	a	b	cc.	a	b	cc.	a	b	cc.	a	b	a	b
March 23 (28 days)	1670	33	23	1495	34	27	1633	32	23	1675	32	24	31	26
April 13 (21 days)	1163	22	5	1504	26	18	1549	27	11	1235	17	0	17	15
Total for Both Plants (49 days)	2833	83		2999	105		3182	93		2910	73		89	

a and *b*. From this table it is seen that, according to the criterion of total growth in length, the ranking of the different cultures was II, III, V, I, IV. Thus cultures II and III were best in both general appearance and in growth. The cause of this may lie in the fact that air was not entirely excluded here, as in I, nor was the water loss by evaporation from soil and pot so great as in IV and V. Very little more water was absorbed by II than by IV, but the total growth in length in IV was only about 70 per cent. of that in II. Where the top of the pot was unsealed the dry soil mulch had a depth of about one centimeter. In these cultures the roots seem not to have suffered from lack of air and to have had a sufficient supply of moisture. From this result it might be concluded that *Vicia faba* succeeds as well or better in an impervious container, when watered by this device, as when grown by the method in common use. Further experimentation would be necessary, however, to establish this conclusion.

The root systems were examined when the cultures were discontinued, and marked differences were noted in relation to the method of watering. In those cases where the water had been automatically supplied, the form and distribution of the roots approached very nearly that which would have been exhibited in the open soil. The roots were more branched and much more uniformly distributed through the soil mass than in the control culture. In the latter, a large proportion of the roots were found massed against the walls of the pot, as is always the case with pot-grown plants watered in the ordinary way, and a poor distribution of absorbing rootlets was observed in the interior of the soil mass. There was practically no massing of the roots on the surface of the pots in the cultures with the automatic arrangement. It is thus suggested that an impervious container with an automatic watering device might be used in pot tests of soils where it is essential that the root system be uniformly distributed and uniformly in contact with the soil. In the present experiments as striking a difference in root behavior was obtained, between the self-watered and the ordinary pot, as that obtained by Livingston et al * and Reed † between the Whitney paraffined wire pot and the glass beaker. This difference was illustrated by Livingston, in the second paper cited (p. 65), and the figure has been re-published by Reed (p. 86).

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*Livingston, B. E., Britton, J. C., and Reid, F. R., Studies on the properties of an unproductive soil. Bull. 28, U. S. Bureau of Soils. Washington. 1905.

Livingston, B. E., Paraffined wire pots for soil cultures. Plant World, 9: 62-66. 1906.

†Reed, H. S., The effect of certain chemical agents upon the transpiration and growth of wheat seedlings. Bot. Gaz., 49: 81-109. 1910.

The experiments here reported seem to indicate that plants may be expected to grow as vigorously and remain in as good condition when watered by the porous clay cup as when supplied with moisture in the usual way. A partial sealing of the pot seems advantageous when the automatic watering device is used. This method of self-irrigation may be used in experiments where it is desirable to maintain the soil moisture approximately uniform, and may also prove useful in measuring the water requirement and water loss of potted plants. It is also adapted to the watering of plants grown for display and similar purposes, decreasing the amount of attention required by the method of daily watering, and obviating the deleterious effects produced upon the plant by the daily alternation of puddled and baked soil.

The Johns Hopkins University,
May, 1910.

TERATOLOGY OF THE BANANA.

By Frank J. Phillips.

A good example of teratology was recently found in a twin banana fruit. The larger part of the twin measured seven inches in length while the smaller part was about two-thirds of

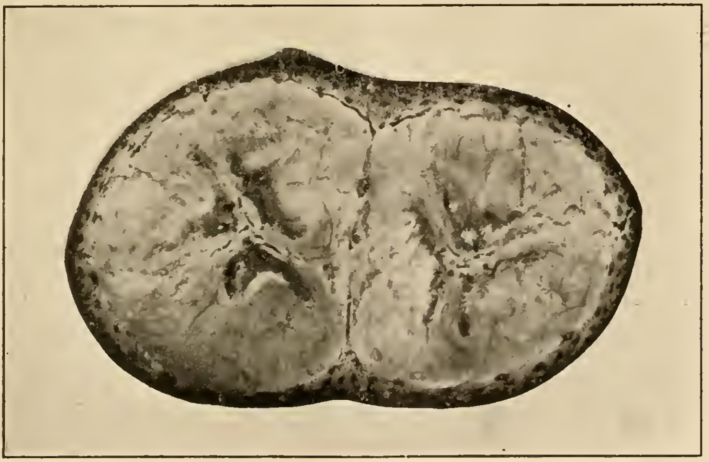

Figure 4.

an inch shorter. The specimen was taken from the center of a bunch of bananas and either part of the double fruit could have been mistaken for single fruit so far as size was concerned.

Cross sections were made from the base to the top of the specimen. For the first half-inch above the fruit stalk the specimen showed two distinct bases with pericarps of normal thickness which were only slightly connected. In this region the fibro-vascular bundles between the two bases were of ordinary size and had their usual distribution. At two inches above the base all exterior indication of two pericarps disappeared except a slight depression along the convex side but cross sections showed that between the two ripened ovaries there was about one-half the tissue of a normal pericarp. This tissue contained seven fibrovascular bundles which seemed to be slightly smaller than normal and had assumed an oval shape because of pressure.

In the middle of the specimen the bundles were still less distinct and somewhat more flattened, while at one inch from the top the bundles became so dwarfed that they were almost obliterated. At the base of the specimen the bundles between the united portions had been quite evenly distributed, but as they came close to the top only the center one remained in position while the three on either side had been crowded over toward the live pericarp. At the top of the specimen along the line of union there was only a trace of the pericarp tissue and this closely resembled the edible portion of the fruit.

As might be expected there was an abnormal thickening of the pericarp at the edges of the union which contained more fibrovascular bundles than any

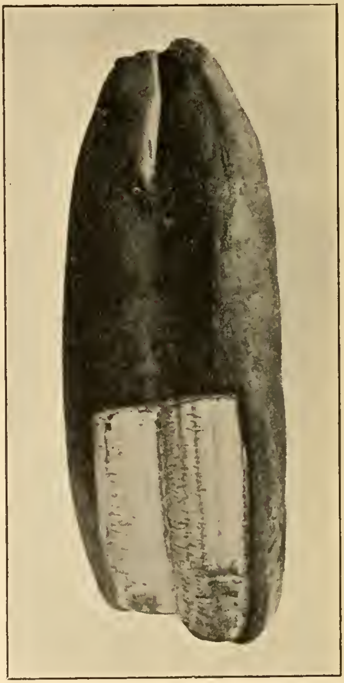

Figure 5.

other part of the pericarp. The relative positions of these bundles changed slightly between the base and the middle of the united portions because of pressure, but otherwise no change could be noted. The seven bundles along the line of union seemed to be functionless, while the extra bundles in the triangular areas were of average size and were functional.

A MANUAL OF CALIFORNIA LICHENS.

BY BRUCE FINK.

Beginning with Menzies (1792), a number of botanists have aided in collecting the California lichens. Other collectors are Farlow, Cummings, Hasse, and Herre. These workers have also studied the plants collected, and Tuckerman, Nylander, Stizenberger and Zahlbruckner have also examined nearly all of the species. Finally we have in Dr. Herre's manual * a valuable treatise on the lichen flora of a portion of the state. The Santa Cruz peninsula is only about 90 miles long and averages about 25 miles wide, but 307 species and sub-species are described in the manual, which will be found indispensable in the study of the lichens of other portions of western North America.

Though an excellent contribution, this Manual contains certain faults which are more or less frequent in similar works on lichens. We lichenists are all given to citing titles of large separates instead of the place of original publication. The following three instances from Dr. Herre's work will serve to illustrate: Wainio Act. Soc. Faun. Flor. Fenn., cited Wainio Mon. Clad. Univ.; Nyl. Mem. Soc. Sci. Nat. Cherb. 5, cited Nyl. Enum. gen. Lich.; and Fries, Th. M. Nov. Act. Soc. Sci. Ups. III, 3, cited Fries, Th. M. Lich. Arc. "A. Zahlb. Ascolichenes" is also an incorrect form often used in the manual. It is easier to find the journals in large libraries, and botanists are not usually acquainted with these excerpts. Consequently the practice of citing them should be abandoned, unless in parentheses with the place of original publication.

There is occasional lack of uniformity in citation as Ust. Ann. Bot., on pages 63 and 65; Tuck. Gen. Lich., on pages 93

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*Herre, A. W. C. T., The lichen flora of the Santa Cruz Peninsula, California. Proc. Wash. Acad. Sci., 12: 27-269. Baltimore, Md., Williams and Wilkins Company. 15 May 1910.

and 106; and Herre Proc. Wash. Acad. Sci., on pages 63 and 109. There are occasional incomplete citations, some giving the author only, others omitting the series, volume number, page, or the year of publication. Absolute uniformity and completeness of citation are difficult to obtain, but are helpful to the student and of sufficient importance to warrant great pains.

The diagnoses are of sufficient clearness and exactness, but often lack certain characters that would have added to their value. Measurements of apothecia are rarely given, though easily made and valuable in determining lichens. Often it is not even stated whether these structures are large, medium sized, small or minute. Measurements of foliose and fruticose thalli are easily made and are very useful in determinations, but they are not given. These measurements may also often be made for crustose lichens, but not for all, since the thallus here is usually a compound structure and often runs together and covers a large area of the substratum. Measurements of asci are occasionally given, and if worth including, they should be given for all species to be had in fruit. Careful statement is more or less frequently made regarding the epithecium, the hymenium, the paraphyses, the asci and the hypothecium, but more or less of this is omitted for certain species or whole genera. A uniform system of examining specimens and a resulting likeness in form is a great aid in using the descriptions. The author has used "hymenium" in some descriptions and the synonymous term "thecium" in others. Uniform use of one or the other of these terms would have been better for the student. As a whole the diagnoses are good and will work well in determining the plants.

Giving spore measurements in the form of a fraction, making a break in the line, makes reading difficult and is an objectionable feature probably introduced by the publishers. Setting off thallus and apothecial characters in separate paragraphs in the descriptions of species is unusual, but is commendable as one is able to refer to the portion of the description pertaining to either more readily. But the author has departed from this plan in occasional species, and this is sure to puzzle for a moment those who become accustomed to his general plan. The descriptions of genera and families are partly run in one paragraph and in part after the plan adopted for the species. It is unfortunate that a general plan was not adhered to for the genera and families.

We find the usual statement of lichenists that the paraphyses are uniformly unbranched in a large number of genera. The student is not likely to notice branched paraphyses in many of these genera without taking great pains, but the writer finds, in a large proportion of these lichens, occasional paraphyses that branch near the apex or nearer the base.

Naming new species should be left largely to persons of long experience and great knowledge, or to those that have made special studies of certain groups. But Dr. Herre has kept the whole number of new species below a dozen in a work dealing with a region having a peculiar lichen flora and deserves credit for holding back unknown material rather than publish a larger number of new species.

The author has avoided the faulty custom of giving an extended and valueless synonymy, copied from earlier works, and has simply cited the original name, the combination used and a few works and herbarium specimens that the student will find helpful in study. Nor has Dr. Herre seen fit to give anything regarding spermagones and spermatia in the descriptions. In this he is in accord with most American workers and has departed from the custom of certain European lichenists. It does not seem that these organs are of sufficient diagnostic value to warrant their incorporation, especially since the student will seldom see them.

The treatment of lichen genera is still a problem. Were one in possession of the knowledge necessary for a revision and at the same time disposed to follow rules of priority, he would find it necessary to make a surprising number of changes and transfers in names of genera. The treatment given by Dr. Zahlbruckner in Engler and Prantl, though by no means final, is the best general arrangement of lichen genera that has appeared, and Dr. Herre has done well in following this excellent work.

A feature of the manual that has not previously found its way into an extended work on American lichens is the general inclusion of chemical tests in the descriptions. Most American workers have been skeptical about the value of the chemical reactions, but the accumulated evidence culminating in the great work of Zopf, * seems to have proved that these tests are of some auxiliary value in the determination of lichens.

One can not pass minutely upon the accuracy and efficiency of keys without subjecting them to the test of use. This remains to be done by those who use the manual, but the keys appear to be excellent. The failure to make good keys is one of the shortcomings of lichenists, and the author has wisely gone through the drudgery of preparing them, thus making his manual easily workable.

Dr. Herre's manual is a valuable contribution to American botany and will fill a long-felt need among botanists of the Pacific slope. It is to be hoped that the author will extend his studies and give us a manual of lichens of the whole western portion of North America.

Miami University,
Oxford, Ohio.

NOTES AND COMMENT.

Suit has been brought by growers of citrus fruits in the vicinity of Colton, California, against a cement factory, the dust from which has been deposited upon the leaves of orange and lemon trees in the neighborhood, apparently greatly to their detriment. Botanical testimony has been taken at length and forms an interesting chapter. Professor Peirce of Stanford and Mr. S. B. Parish of San Bernardino, were summoned to give expert testimony, and have promised at the proper time to present in THE PLANT WORLD the results of their observations and experiments.

A notable and most useful contribution to the literature of scientific pedagogy is again presented to botanical teachers in a new and extended edition of "The Teaching Botanist," by Professor W. F. Ganong. It should find a place in the working library not only of botanical teachers but of teachers of all subjects who are interested in the development of pedagogy as a science and at the same time as a practical matter, of which at present many who are practicing the art have need that some one should teach them the elements. The work will be further reviewed as soon as space permits.

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*Zopf, W. Die Flechtenstoffe. I-XI. 1-450 f. 1-71. Jena, Gustav Fischer, 1907.

The "cryptogamically minded" botanists (using Dr. Asa Gray's quizzical term of toleration) were ably represented at the botanical congress at Brussels, and may well congratulate themselves on having materially contributed to a better understanding in matters of nomenclature that have been like the troubled sea casting up mire and dirt for so many years. Specialists in different groups of Cryptogams held conferences for the purpose of agreeing upon dates to be taken as "starting points," and their recommendations were adopted by practically unanimous vote of the congress.

If the study of microbes belongs to botanical science we have to thank the magazines for its popularization to a hitherto unheard-of extent. Pictures of such uncanny things as flies on the way from a dead fish to the baby's bottle may cause a momentary feeling akin to that of seasickness, but it is good for us to be brought face to face with the facts of the case and such heroic measures can hardly fail to produce an impression that should lead to determined action. The August number alone of the *Technical World Magazine* contains articles on "Campaigning Against the Fly," "Pellagra caused by Gnat," and "Measles and the Mouse." Such things as the "Lady or the Tiger" and other fashionable literature of earlier years, and even the modern sport of muck-raking seem to have taken subordinate rank as thrillers. So staid a journal as the *Review of Reviews* shows up the bacteria left on a gelatine plate by a fly's feet, and, with what seems like gusto, pictures a popular fly route from garbage can to dinner table with the words "disgusting but eloquent." Two recent numbers of the *National Geographic Magazine* have articles on the same subject. In short if people continue to perish for lack of knowledge it will not be because the reporters have failed to get after the laboratory men.

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Volume 13 **Number 10**

THE PLANT WORLD

A MAGAZINE OF GENERAL BOTANY

OCTOBER, 1910

THE RATE OF ESTABLISHMENT OF THE GIANT CACTUS.

BY FORREST SHREVE.

The characteristic openness of desert vegetation affords ample room for the establishment of new individuals of the perennial species, a marked contrast to what is true of forests or grassland. The number of germinations that take place during any rainy season in the desert is very great as compared with the number of establishments that result from them. The low water-content of the soil,—which is by far the most important factor in preventing establishment,—most frequently operates to kill seedlings soon after the close of the rainy period in which they germinated, or, in a smaller number of cases, becomes operative after several years of successful growth have brought the root systems into regions of the soil that are already being drained by perennials that have been established for a long time. The rainy seasons of the southwestern deserts vary from year to year in the amount of rainfall and in their duration, fluctuations which have much to do with the persistence or death of the seedlings.

The widely diverse types of desert perennials differ greatly in their behavior as respects germination under natural conditions and as respects the stage in their early life at which the factors that inhibit establishment become operative. In general the schlerophyllous shrubs have numerous germinations, with a very high death rate at the end of the first growing season and a rather high one in the second and third years. The succulent perennials,—at least the cacti,—have few germinations, but the percentage of survivals among them is very high, not only in the first but in the succeeding years. The deeply rooted seedlings of the sclerophyllous types which survive the first dry period after germination are almost exclusively killed only by low and prolonged depressions in the annual curve of soil moisture, while the relatively shallow-rooted seedlings of the cacti are much more liable to mechanical injury or destruction by the erosion accompanying heavy rains, by the impact of severe rainfall, by the burrowing and scratching of rodents, or by being eaten by rodents in search of moist food.

In order to determine the rate of establishment of one of the most characteristic desert succulents, the following statistical method was devised and applied to the Giant Cactus (*Carnegiea gigantea*, *Cereus giganteus*). By reason of their simple form the young, unbranched Giant Cacti may be measured easily and their rate of growth determined with accuracy. Mrs. E. S. Spalding carried out a set of such measurements for several years and has been good enough to permit the use of her figures in advance of their prospective publication. The sixteen individuals measured by Mrs. Spalding were of all sizes from 1 to 15 dm., and some of them were followed through four years. Her data have been supplemented by measurements on two lots of seedlings of known age and by computation of the rate of in a few individuals over 15 dm. high. Young plants less than 1 dm. in height are so rare, or inconspicuous, that nine botanists who have had excellent opportunities to find them report that they have never done so, and there is accordingly some doubt as to the growth rate during the earliest years under natural conditions. The assumption that individuals 1 dm. in height are eight years old is based partly on the direction of the growth curve to be mentioned, and partly on the growth rate of two lots of seedlings, one and two years old, which (unfortunately for this purpose) have been grown under partial irrigation. The growth rate of the individuals over 15 dm. in height was obtained by comparing old photographs of certain individuals in the vicinity of the Desert Laboratory with their present size. The conspicuous forkings of the ridges common to all Giant Cacti, served to give measurements from fork to fork, and from the uppermost fork to the tip, that supplied reasonably accurate data, showing an average rate of 15 cm. per year.

With the growth data in hand, a curve of growth was secured by plotting rates of growth in cm. per year with heights in 10 cm. intervals. From the smoothed curve the average rates were taken for the 10 cm. intervals, and by summation a set of figures was obtained showing the approximate age of the Giant Cactus at successive heights, some of which are given here.

10 cm.	8.0 years
20 "	12.5 "
40 "	19.1 "
80 "	27.3 "
1 m.	30.3 "
2 "	40.5 "
3 "	47.5 "
4 "	54.0 "
5 "	60.0 "

In order to apply these figures to a determination of the rate of establishment, an exact census was taken of some 240 Giant Cacti, which formed the entire population of a portion of the northern slope of Tumamoc Hill, including easterly and westerly slopes. All the unbranched individuals less than 5 m. in height were measured; the five individuals encountered which had branched before reaching that height were disregarded in the computation to follow, on account of the disturbance of their growth rate due to the production of the branches. The individuals under 5 m. in height, which is to say those less than 60 years old, formed 36% of the total population, which would indicate an average expectancy of life of 175 years for the Giant Cactus in this location and habitat. On the steep rocky flanking slopes of the hill there was a noticeable poverty in young and middle-aged plants and an abundance of fallen skeletons, while the number of younger plants was greater on the gentle slopes facing the east and west, which points to erosion as one of the most important factors in limiting the length of life.

The height measurements of the juvenile element of the population—as we may term those under 5 m. in height—were converted into ages, and these grouped into pentads. The number of the surviving individuals of each pentad was then plotted with reference to the years in which their establishment took place, with the resulting curve shown in Fig. 1. The variations in the growth rate of different individuals make it possible for some of those that were measured to fall into the adjoining pentad to that in which they belong, or even, in extreme cases, to fall two pentads from where they belong. The rapid and consistent fall of the curve, however, makes it appear probable that the errors of the method have largely neutralized themselves. The lack of germinations during the last three pentads may be partly due to the overlooking of small individuals, but those which are ten years old should be about 18 cm. high and those 15 years old nearly 30 cm. high, which would have made it difficult to overlook them.

This curve as drawn is actually an age curve for the surviving population, and falls short of being the curve of the rate of establishment by just so far as there have been deaths among the juvenile population during the 60 years since 1850. Deaths among the juvenile and adult cacti, just as with the seedlings, are due in at least 90% of cases to mechanical factors,—erosion, wind, lightning, etc., followed by the work of bacteria and fungi. The deaths of the last six or eight years on the area over which the census was taken, as indicated by fallen skeletons and stumps, were all among the older two-thirds of the population, but during the sixty years there must have been some deaths among the juvenile third, which if known would increase the steepness of the curve, making it a true curve of the rate of establishment.

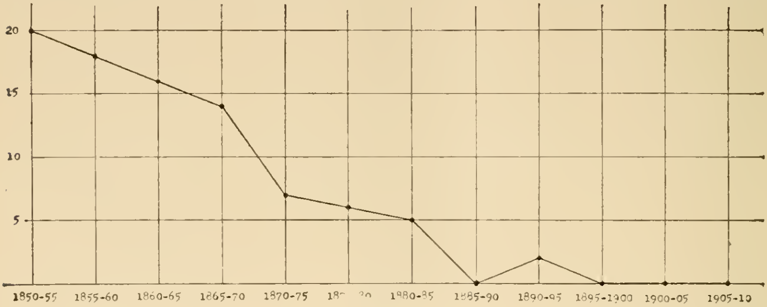

Figure 1.

The probability seemed strong that the fall in the rate of establishment of the Giant Cactus on the north slopes of Tumamoc Hill is related to the fact that it is always more abundant on southern than on northern slopes in the vicinity of Tucson. To carry the method used to other localities raised the objection that the growth data used as a basis were secured on individuals growing on the north slope of Tumamoc Hill, and were not applicable to cacti growing elsewhere. A few data as to the growth of adults on the mesa in the vicinity of Tucson, obtained by the photographic method, show a yearly rate of 7 cm. as against 15 cm. on Tumamoc Hill. So great a difference is entirely in accord with the higher average water-content of the soil of Tumamoc Hill as compared with the mesa, a difference which is accompanied by profound differences in the character of the vegetation. However, in the absence of any other growth data, those of Mrs. Spalding have been used, with an error which finds expression in a shortening of the x-coordinate of the curve, so as to make the rate of establishment which has been going on for 100 to 120 years appear as that of the last 60 years, without producing any alteration in the character and significance of the curve.

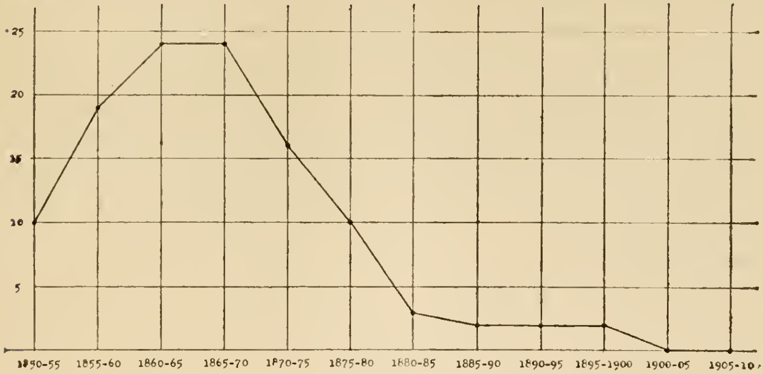

Figure 2

In order to secure a census of an area with southern exposure a steep slope at the base of the Santa Catalina mountains was chosen, where the population is very dense, the younger individuals being conspicuously numerous and the old much-branched ones infrequent. The growth rate in this situation is undoubtedly lower than on Tumamoc Hill and probably as low as on the mesa near Tucson. A census of 175 plants was made, of which 64% were less than 5 m. in height,—or less than 60 years old. Plotting the ages of the juveniles, as before, the curve shown in Fig. 2 was obtained. In the area covered by this census there was very little small vegetation to hide seedlings and small juveniles, yet the curve shows the same fall during the last eight pentads. The fact that there is a rise in the curve during the first two pentads is undoubtedly due to severe erosion having destroyed many of the individuals from 50 to 60 years of age. The steepness of the slope, the instability of the soil and rock covering, together with the shallow rooting habit of the Giant Cactus make it certain that the curve of establishment, as contrasted with this curve of the age of the survivors, would fall much more rapidly, and it is altogether likely that it would not rise during the first two pentads, but would fall from a high rate of establishment between 40 and 50 individuals per pentad.

The striking fall in the establishment rate of the Giant Cactus shown by these two curves compels the conclusion that it is not maintaining itself in either of two situations, one of which offers the highest average water-content of any desert soil away from stream beds, and the other the temperature and other conditions which have brought about in it the densest Giant Cactus population that can be found in any habitat. It is bootless at this time to attempt to explain the apparent decadence of the Giant Cactus. A fuller knowledge of its germination and the behavior of its seedlings, together with a more complete knowledge of the periodicity of certain climatic elements within its range will be sure to throw light on the fall in its rate of establishment.

The Desert Laboratory,
Tucson.

MISTLETOE IN THE SOUTHWEST.

BY J. C. BLUMER.

So far as collected by the writer, the Loranthaceae, parasitic upon trees and shrubs, their distribution naturally limited by that of their hosts, are represented in the Southwest by ten species and varieties, belonging to two genera, Phoradendron and Razoumofskya. The latter comprises two species, both of which belong to the mountains, and have the pines for their hosts. Both species, *Razoumofskya robusta* and *R. divaricata* (?), have been collected in the Rincon and the Chiricahua mountains, the latter upon *Pinus chihuahuana*, thickly infesting some trees, the former upon *P. arizonica* and *P. mayriana.* Apparently the same species, not fully developed in two cases, and inaccessible in the third, was also seen on the Mexican white pine (*P. strobiformis*) in both ranges as well as the Santa Catalinas. In this range it likewise occurs upon the Arizona pine, on which it is also found in the Santa Ritas. On this host *Razoumofskya robusta* is abundant in many places, attacking young trees as well as old, stems as well as branches, but has never been seen to prove fatal.

The larger genus, excepting a form found upon white fir, extends from the pine region downward. *Phoradendron juniperinum* and *P. bolleanum*, are found only upon the junipers, hence are restricted to the zone of these. Both species occur upon *Juniperus monosperma* and *J. pachyphloea*.* In the Chiricahuas both have been found repeatedly, not only upon each host species, but also on the same individual tree of each species. Their ranges may thus overlap, but while *P. juniperinum* extends toward Razoumofsyka above, *P. bolleanum* apparently follows *J. monosperma* to the lower limit of the juniper belt. All the preceding but *P. bolleanum*, which is narrow-leaved, are leafless, corresponding to the narrow-leaved character of their coniferous hosts.

With the oak zone, and extending in the deciduous-arboreal seams of the watercourses far down into the desert, but nevertheless distinctly Upper Sonoran, appears the broad-leaved and polymorphic *P. flavescens*. Its variations, their structure and color, correspond to similar variations in host and environment. Some of these have been described by Dr. Engelmann † under the following varietal names. The most common variety, *villosum*, belongs very largely to the evergreen oaks, but a variety with roughened leaf surfaces also occurs upon the deciduous, but very scabrous hackberry (*Celtis reticulata*). *P. flavescens orbiculatum*, with its small, round, yellow leaves, occurs in exposed places upon *Quercus Toumeyi*, one of the most xerophytic of oaks. On the other hand, the smooth, dark green *P. flavescens macrophyllum* is found upon ash (*Fraxinus velutina*) and other hosts furnishing good water supply and protection from wind and sun.

The species has its favorite hosts among the oaks as well as the deciduous trees. The oaks with white bark are preferred to those with black bark, whose wood, at least in *Quercus Emoryi*, is harder and more brittle. Its smooth forms, having larger leaves are common and sometimes of overpowering abundance, on such water-loving trees as ash, walnut, cottonwood, and soapberry ((*Sapindus marginatus*). But the sycamore (*Platanus Wrightii*) and the desert willow (*Chilopsis linearis*), of the same habitat, are practically immune. The desert willow, in one instance on Bonita Creek, Cochise County, Arizona was found to divide the ground with ash. This was being exterminated by very numerous bunches of mistletoe, but not one could be detected upon the desert willow. No experiments are necessary to prove its immunity under the conditions there given. It is valued by stockmen as an excellent and durable wood for fence posts, also in this respect showing affinity with its bignoniaceous relative, the famous catalpa. No great damage by mistletoe need therefore be feared in reservations or plantations of desert willow.

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*The new combination "Sabina pachyphloea" has been published, but "Juniperus monosperma" remains intact.

†Watson's Botany of California, pp. 104-107, 1880.

It is the pleasing green, luxuriant development, and abundance of white berries of the smooth-leaved forms of this variable species, growing near ranches, settlements and in riparian situations generally, that make the mistletoe much sought for Christmas and other decoration.

Finally, the false mistletoe (*P. californicum*) is entirely Lower Sonoran in choice of hosts and hence in distribution. Its leafless character fits well into the drouth and heat of the desert, nevertheless it manifests a preference for the larger, comparatively well-watered individuals of mesquite and *Acacia Greggii*. Groups of trees near water or human habitations are occasionally found heavily infested with this thrifty parasite, bearing quantities of red berries. It is hoped to touch upon the causes governing its distribution at another time.

To substantiate what has been said mainly in outline, and for more exact reference, the records follow, for the sake of brevity only partially detailed. At present no attempt is made to give the references in literature. In 1906, six species of mistletoe were recorded as occurring upon 20 host species in various parts of the Chiricahua Mountains, nearly all occurrences upon the different hosts having been collected and distributed. These are as follows:

MISTLETOE SPECIES.	HOST SPECIES.
Razoumofskya robusta (Englm.) Kuntze R. cryptopoda (Engelm.) Coville	Pinus arizonica Engelm.
Razoumofskya cyanocarpa A. Nels?	Pinus strobiformis Engelm.
Razoumofskya robusta (Engelm.) Kuntze	Pinus mayriana Sudw.
Razoumofskya divaricata (Engelm.) Kuntze*	Pinus chihuahuana Engelm.
Phoradendron juniperinum Engelm	Juniperus pachyphloea Torr.
Phoradendron juniperinum Engelm	Juniperus monosperma Engelm.
Phoradendron bolleanum Eichler	Juniperus pachyphloea Torr.
Phoradendron bolleanum Eichler	Juniperus monosperma Engelm.
Phoradendron flavescens Nutt	Fraxinus velutina Torr.
Phoradendron flavescens Nutt	Fraxinus sp.
Phoradendron flavescens Nutt	Populus Fremontii Wats.
Phoradendron flavescens Nutt	Populus angustifolia James.
Phoradendron flavescens Nutt	Salix nigra Marsh.
Phoradendron flavescens Nutt	Salix taxifolia HBK.
Phoradendron flavescens Nutt	Juglans rupestris Engelm.
Phoradendron flavescens Nutt	Platanus Wrightii Wats.
Phoradendron flavescens villosum Engelm	Quercus arizonica Sarg.
Phoradendron flavescens villosum Engelm	Quercus Emoryi Torr.
Phoradendron flavescens villosum Engelm	Quercus oblongifolia Torr.
Phoradendron flavescens villosum Engelm	Quercus reticulata HBK.
Phoradendron flavescens orbiculatum Engelm	Quercus Toumeyi Sarg.
Phoradendron flavescens macrophyllum Engelm.	Fraxinus velutina Torr.
Phoradendron californicum Nutt	Prosopis velutina Wooton.

In the Santa Catalina range occurs a most interesting form of Phoradendron on white fir (*Abies concolor*), the only instance yet noted of a mistletoe with leaves growing upon a needle-leaf host. As early as 1880 Dr. Engelmann records it upon the same host as an unusual form allied to *P. bolleanum*. It is distinct in lack of pubescence and general form, and very decidedly so in habitat and host. As already noted, *P. bolleanum* is common at about 5,000 feet elevation in the Chiricahuas, ascends on the alligator juniper (*Juniperus pachyphloea*) to approximately 6,500 feet on the Swisshelms, and on the one-seeded juniper (*J. monosperma*) descends to 3,500 feet above Vail, and equally low in Cañon de los Alisos, which transects the Mexican boundary. It was also noted on alligator juniper near Oro Blanco Peak, elevation about 4,500 feet. This region, known as the Pajarita mountains, was found devoid of *P. juniperinum* but on the east side of the Santa Ritas this species was found abundant on the one-seeded juniper, while in the Santa Catalinas it occurs on the alligator juniper. In New Mexico it is very abundant, almost destructive in places, on the former host, and also present on the latter, both growing in the foothills near Fort Bayard.

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*Probably wrongly distributed as R. vaginata. It resembles R. divaricata but as it has not been found on the pinyon hosts of this species, and does occur on Pinus chihuahuana, and as this belongs to a group of pines that are the hosts of R. americana, it may be the latter or an allied species.

As already indicated, the true mistletoe (*P. flavescens* and varieties) is within the zone of its hosts of wide distribution, inhabitating the Elevated Central Tract, and extending eastward at least to Fort Bayard and the Rio Grande. In the Dragoon mountains it was first seen upon *Celtis reticulata*, adding another host to those harboring it in the Chiricahuas. This host has been noted for two localities in the San Pedro Valley, McCleary's ranch in the Santa Ritas, and Rincon Creek. On the walnut (*Juglans major*) the smooth form of the species occurs, aside from the Chiricahuas, in the Dragoons, Mustangs, Santa Ritas, and many other localities. Near Fort Bayard, New Mexico, a smooth form was found present upon deciduous white oak, usually passing as *Quercus Gambelii*. In the long and tortuous Cañon de los Alisos it is found on ash, walnut, and black willow (*Salix nigra*), but none was found upon the large and numerous sycamores after which this well watered canyon is named. In fact the only known occurrence upon this host is on a single tree at Wilgus Ranch in the Chiricahua Mountains. On the desert willow it has never been found.

On the cottonwood of the Sonoran Zone, usually designated as *Populus Fremontii*, marking the best watered spots by small groves and isolated trees, it has been seen on the Rio Grande, the Santa Cruz, and many times between. Perhaps more often than on any other tree, it is seen on the much more numerous ash of the lower altitudes (largely *Fraxinus velutina*). Numbers of these trees are apparently being killed by this parasite on Cottonwood and Bonita creeks in the Chiricahuas and many other places. Over the border in Sonora, on the headwaters of the Rio Altar,it was discovered upon a very small and peculiar ash (*F. cuspidata*?) and upon the soap berry (*Sapindus marginatus*). The latter host was seen supporting large quantities of the parasite on Rincon Creek,being greatly preferred to the more numerous hackberry. It is less common on the willow, for aside from one or two stations in the Chiricahuas and one on the boundary already noted, it was seen in the Dragoons only, on *Salix taxifolia*.

The variety *villosum* attains probably its most general distribution on *Quercus arizonica*, having been seen frequently on this widely prevalent host in at least six or seven mountain ranges. It is also common on the blue oak (*Q. oblongifolia*), of lesser altitudinal range, being noted from the Catalinas, Rincons, Dragoons, and of frequent occurrence in many parts of the Chiricahuas and Oro Blancos. In the three last-named ranges it affects also the Toumey oak, usually in the form of the variety *orbiculatum*. On the whole it is decidedly infrequent on *Quercus Emoryi*, having been noted but rarely in the Chiricahuas and Catalinas, and not at all in the Oro Blancos and Rincons. Rather anomalously, it was found abundant on many trees in the Santa Ritas near Rosemont. It has been recorded once only on *Q. reticulata*, viz., a tree in Shake Gulch of the Chiricahuas. This rarity may be due to the high range and usual shrubby character of this oak. It has never been seen to affect the widely prevalent *Q. hypoleuca*.

Phoradendron californicum was first seen between Benson and Mescal, on mesquite, and on the Pantano Wash at Vail on *Acacia Greggii*. Subsequently it was noted on one or both of these hosts on the San Pedro River, Babocomeri Creek, in the Roskruge Range, the Altar Valley, and a large number of desert washes, ranches, and other localities in southern Arizona as well as across the boundary in Sonora. It is especially heavy on acacia on lower Arivaca Creek, occurs on the same and on palo verde (*Cercidium Torreyanum*) near the Roskruge Range on the latter host near Palo Alto, and is conspicuous and abundant, on this host as well as on *Prosopis velutina* and *Parkinsonia microphylla* on comparatively well watered portions of the bolson plain sloping northward from the Sierritas.

It may be helpful, finally, to give somewhat more detailed occurrences in the vicinity of the Desert Laboratory domain. Within the tract itself the parasite occurs upon *Prosopis*, not infrequently upon *Parkinsonia microphylla*, and near the summit of Tumamoc Hill it has been located upon a bush of *Acacia constricta*. Later it was noted several times upon the same host below the Pueblo Mine, and at the head of Tumamoc Wash in the Tucson Range, where it likewise occurs upon the other *Acacia*, upon *Cercidium*, *Parkinsonia*, and *Condalia spathulata*. The first note of its occurrence upon the last named host, like *Acacia constricta* exclusively shrubby, was made some miles east of Vail. With the more common hosts already mentioned were again found *Parkinsonia microphylla*, *Acacia constricta*, and *Condalia spathulata* in the Catalina foothills. At Quijotoa Pass, in the Tucson Range, *Olneya tesota* proved to be still another host.

In summing up, it is found that the desert mistletoe has thus far been detected upon seven hosts, all desert trees and shrubs, while the various forms of *P. flavescens* occupy 17 hosts and occur on trees only, and excepting the one mistletoe on Gambel oak, exclusively Upper Sonoran. Two more species of Phoradendron are confined to two junipers each, another species or variety to white fir, and Razoumofskya to the pines. The ten species and varieties of mistletoe have thus far been located upon a total of 31 host species.

Tucson, Arizona.

A NOTE ON TWO SPECIES OF THE GENUS CALOSTOMA.

BY HOWARD S. REED.

The members of this genus, while not abundant, appear to have a wide distribution. The plants, on account of their peculiar shape and unique appearance, are quite striking objects and very interesting to the collector. At maturity, the little stalks, formed of reticulated and anastomosing cords, bear aloft a delicate fruit body in which the spores are contained. The exoperidium early becomes gelatinous and, splitting from below upwards into radial strips, falls away, exposing the permanent endoperidium. The wall of the endoperidium opens at the top by four to seven teeth whose inner surfaces and margins are brightly colored. The corona of teeth opens into the spore sac, which, at maturity, slowly contracts, forcing the spores out between the valve-like teeth.

In America the first species appear to have been described by Plukenet* in 1691. Since then numerous mycologists have noted, in one way or another, the characters of this genus.

Calostoma cinnabarinum (fig. 1) appears to be one of the most widely distributed species of this genus and was undoubtedly the one described by Plukenet. In his monograph of the genus Calostoma, based upon material in the British Museum, Massee † assumes reasons for including *C. lutescens* (fig. 2) in the species *C. cinnabarinum*. The confusion which this unfortunately produced was subsequently corrected by Burnap * who clearly pointed out differences between these two species sufficient to establish their identity. Chief among these differences as pointed out below, is the size of the plant and the nature of the footstalk.

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*Phytographia, p. 184, 1691.

†Annals of Botany, Vol. II, p. 25 1888.

During the last two years the writer has been interested to note these two species growing in the vicinity of Blacksburg, Va. The specimens illustrate the specific differences so well that attention may be here called to them. *C. cinnabarinum* was collected November 7, 1908, in a ravine on Brush Mountain. At that time the plants were mature and the notes could not be obtained upon the character of the volva. *C. lutescens* was collected April 13, 1910 in moist woods by Mr. H. S. Stahl of the Department of Biology. The following table shows the average size of the plants as determined from the specimens collected.

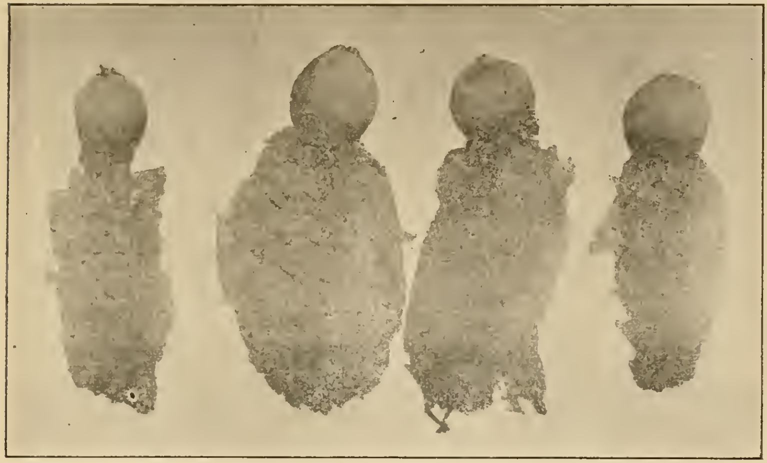

Fig. 1. Calostoma cinnabarinum. Desv. (for size of plants see table.)

AVERAGE MEASUREMENTS OF SPECIMENS OF C. CINNABARINUM AND C. LUTESCENS.

	Height of entire plant	footstalk	Diameter of footstalk	Diameter of peridium	Size of spores diameter
C. cinnabarinum.........	68 mm.	47 mm.	24 mm.	17 mm.	6-7 x 14-15 microns
C. lutescens..................	84 mm.	68 mm.	13 mm.	15.5mm.	7-8 microns

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*Bot. Gazette, Vol. XXIII, p. 180. 1897.

The peridial teeth of *C. cinnabarinum* are bright vermilion and very conspicuous, those of *C. lutescens* are lemon-yellow on the margin and pale vermilion within. There is, furthermore, a very notable difference in the character of the footstalks. *C. cinnabarinum* has a footstalk which becomes decidedly gelatinous in the presence of water, whereas the footstalk of *C. lutescens* does not become distinctly gelatinous but has a rather harsh, woolly character. It is also characterized by being more open and possessing larger meshes. Its color, as noted by Burnap, is notably yellow, whereas the other is red-brown, or brownish. The spores also agree closely with Burnap's description. Those of *C. cinnabarinum* are elliptic, oblong and echinulate, 14 to 15 microns long by 6 to 7 wide. The spores of *C. lutescens* are unmistakably globose, verrucose, 7 to 8 microns in diameter.

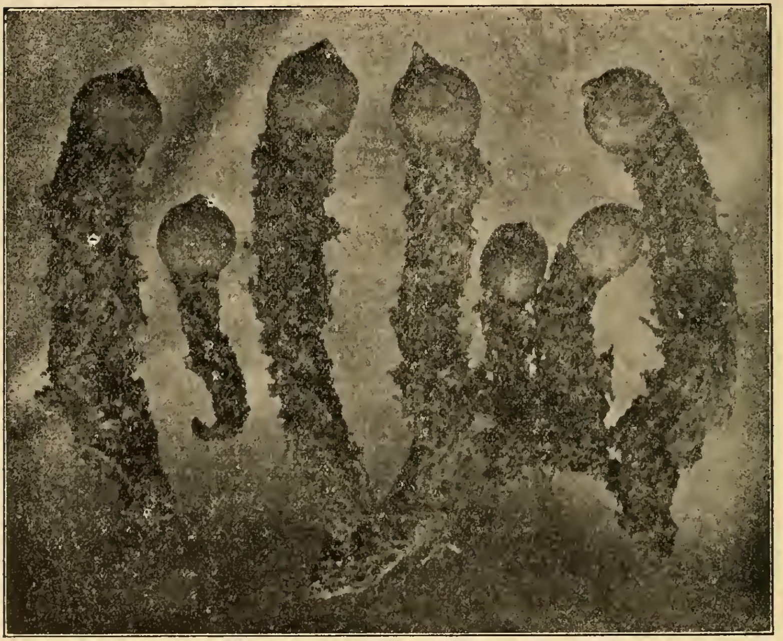

FIG. 2. Calostoma lutescens. (Schw.) Burnap. (For size of plants see table.)

Virginia Polytechnic Institute.

LICHENS OF MINNESOTA. *

BY ALBERT C. HERRE.

The thanks of botanists in general and of students of lichens in particular are due to Professor Fink for the care and discrimination he has shown in preparing this volume, the best piece of work yet published on lichens in this country.

The first thirty-six pages are taken up by the introduction in which the aims of the work are considered and a careful résumé is given of the structure, functions, and life relationships of lichens. This part is a very clear and able presentation of the essential facts concerning lichens and should be read by every one who desires a general idea of these plants. After setting forth the leading opinions on the subject, Professor Fink decided for practical reasons and because of the lack of agreement among botanists that it was best in the present paper to follow Engler and Prantl in recognizing the class Lichenes, instead of distributing lichens among the fungi. But he further states that in a general systematic treatment further study may lead to the distribution of lichens among the fungi, to the exclusion of the class Lichenes. The reviewer,who believes that Lichenes must eventually be discarded as a class, hopes that Professor Fink may soon be able to publish his views upon this point in some detail.

The author states (p. 33) "But it is certain that the fungus forming the lichen takes more or less of crude or elaborated food materials from the substratum," but it might have been better had he given some illustrations or data on this topic. For it is likewise certain that in at least some cases the lichen derives nothing from the substratum; as an instance I may cite the lichens growing on the iron fence which until recently surrounded the grounds of the Normal school in San Jose, Cal.

The reviewer agrees with Professor Fink (p. 36), that "it is probably not worth while to take time to remove lichens from any trees of temperate regions for the sake of saving the trees from injury," but it has been found best in some of our California fruit districts to remove the lichens from the fruit trees because of the injurious insects which they harbor.

Following the introduction is the descriptive catalog of 211 pages, which includes an outline of classification, an artificial

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*A Review of "The Lichens of Minnesota," by Bruce Fink. Contributions from the United States National Herbarium, volume 14, part I. pp viii-269-XVII, with a frontispiece 51 plates and 18 text figures; issued June 1, 1910.

key to the genera, and descriptions of the families, genera, and species represented in Minnesota, keys to the species being given wherever necessary. In this part of his work Professor Fink has of course been guided in his arrangement by the views of several authors, especially Dr. Alexander Zahlbruckner, but he has been courageous enough to arrange the families and genera according to his own ideas. His system naturally differs widely from that of Tuckerman, the only other independent American writer, while he recognizes some genera not accepted by Zahlbruckner in Engler and Prantl and discards other genera held valid by many European authors. But in the present unsettled state of nomenclature in cryptogamic botany it would be strange were it otherwise. In his definition of species the author has in the main followed the treatment of Tuckerman, tending to consider a species as a group composed of a number of sub-species and varieties.

The treatment of the different genera naturally differs somewhat; that of the *Cladonias* is particularly good, as that genus is exceedingly well represented in Minnesota. As Professor Fink is our foremost American student of this most puzzling group this adds a special value to the work.

The descriptions in general are terse without being scrappy, and clearer and in simpler language than any ever before written dealing with our eastern lichens. In each instance the technical description is followed by valuable observations and data on the distribution of the species both in Minnesota and elsewhere. All chemical tests for the determination of species are omitted, thus disregarding the practice of the European lichenologists. The text figures and many of the plates are valuable in exemplifying the structure and spore characters, while the plates made from field photographs of growing lichens are one of the most valuable features of the book. The addition of a glossary is a commendable feature enabling those not specialists to use the work more readily.

For the region east of the Rocky mountains and north of the Gulf states the work will serve satisfactorily for the determination of nearly all lichens found therein, while it will be an indispensable work of reference for the student of lichens in any part of North America outside the strictly tropical portion.

An ample bibliography, prepared by P. L. Ricker of the United States Department of Agriculture, follows the descriptive portion. Students who have vainly sought some necessary reference will thank the author for indicating the libraries where the works cited were consulted. But it seems a pity that the list of libraries was limited to those where the works were actually consulted. Had it been extended to include those in the western part of the United States, it would have been of much greater benefit to students in the western United States.

Professor Fink is to be congratulated upon the excellent typography and well printed illustrations of his paper, as so many works on lichens have been spoiled by inferior mechanical workmanship. The volume seems to be quite free also from typographical errors, those noted by me being relatively unimportant and not at all confusing to any one; for example the reference on page 14 to fig. 17 should be page 240 and not page 239, but this and similar errors would not cause any trouble. On page 149 are the words "Nylander's *Heppia arenivaga* from Japan"; this is an error, the locality being given by Nylander as Colorado. On page 156 the statement is made that *Sticta fuliginosa* "is so near to the last (*Sticta limbata*) that the two are very difficult of separation." This may perhaps be true but it certainly does not hold good here on the Pacific Coast where both species are well represented from the Santa Cruz Peninsula to the Columbia River.

The inclusion of the parasitic fungi under the genera *Buellia* and *Lecidea* is open to criticism as it would be a difficult matter to prove them real lichens; the reviewer believes their omission would have strengthened the work. The same is true of the family Leprariaceae, composed of undeveloped or pseudolichens, which are probably only common species which never develop properly. Viewed in this way *Amphiloma lanuginosum* (p. 247) is not to be regarded as a genuine lichen species.

With the publication of such an admirable work as this by the National Museum the future of the study of lichens seems more promising than ever before in this country. With such a manual at hand we may confidently look forward to a great increase in the number of those who study this assemblage of remarkable plants. Now if a few more local floras are prepared which attain the same standard of excellence characteristic of Professor Fink's work the time will not be far distant when a really satisfactory North American lichen flora can be prepared.

Oakland, California.

BOOKS AND CURRENT LITERATURE.

Miyoshi, in the Journal of the College of Science of the University of Tokio, has published his "Botanische Studien aus den Tropen," based upon observations in Java, chiefly in the Botanical Garden of Buitenzorg. The present paper deals with tropical leaves in regard to form, size, and number, texture, periodicity of formation and other characteristics. Special attention was given to the capacity of such leaves of becoming wet. The results as summarized by the author are as follows:

(1) Trees and shrubs in Java and in other moist regions of the Indo-Malayan tropics, in contrast with Japanese species, possess for the most part leaves that are readily wetted on both sides.

(2) The capacity for wetting is to some extent dependent on the age of the leaves. Many young leaves which are not capable of being wetted become so later.

(3) There are, however, numerous leaves which exhibit this capacity when young as well as when they are old.

(4) The capacity of tropical leaves of easily becoming wet is not limited to plants of moist tropical regions. The leaves of many trees in relatively dry tropical regions also possess this characteristic.

(5) The degree to which they are capable of becoming wet does not depend upon leaf form. There are many leaves which have no channelled tip which are nevertheless easily wetted.

(6) It appears as if in some cases the capacity for becoming wet is connected with the systematic position of the plant in hand. Most of the Leguminosae, for example, which were investigated by the author, though belonging in very different habitats, have leaves either absolutely incapable of being wet or becoming so with difficulty.

In recent numbers of the Boletin del Comite Regional del Estado de Durango, Prof. Isaac Ochoterena has published an account of the "Botanico-Geographical Regions of the State of Durango." The territory in question may be divided fundamentally into dry plains and valleys and moist mountain and upland regions. The physiographical features of the former are discussed in some detail, and a carefully prepared list is given of the principal phanerogams growing wild and in cultivation.

In the same journal Carlos Patoni presents a paper on the "Distribution of the Cactaceae in the State of Durango." This southward extension of more definite knowledge of a region regarding which our understanding of physiographical and distributional relations has been too limited will be welcomed by botanists of the United States.

The retiring address of C. V. Piper, as President of the Botanical Society of Washington, on "Botany in its Relations to Agricultural Advancement" presents many thoughts worthy of careful consideration. The difficulty of condensation of what is already so admirably stated justifies the direct reproduction of some of the most striking passages.

"The very baffling nature of the problems presented (those regarding the origin of varieties of cultivated plants), instead of attracting students, seems to repel them. Systematic botanists have looked upon cultivated plant varieties as artificial products, useful, no doubt, but utterly subversive to notions of classification obtained from plants in their natural habitats. * * * The natural result of this has been that the systematic botany of cultivated plants is in woeful confusion, and as a consequence of this neglect by botanists, the great mass of information we have concerning any cultivated plant is largely the work of men of little or no botanical training. * * * There has been placed on record a mass of misinformation regarding many varieties. In my opinion, at least fifty per cent of the varieties that have been published upon are either untrue to name or unidentifiable. The task (a comprehensive study of the whole botany of our principal crop plants) is by no means an easy one. In the first place the number of varieties in all our crop plants is far greater than has commonly been realized. For example, there are about 2,000 varieties of wheat, 1,000 of beans, 5,000 of apples, 200 of sorghums, etc. What is needed is not so much descriptions and detailed classifications of these varieties, as a classification and understanding of their principal hereditary characteristics. In other words, the knowledge of them needs to be arranged not only with regard to the existing forms, but also as far as possible with regard to their characters and potentialities. Such a monograph does not exist for a single one of our principal crops.

"It is remarkable that thus far so little has been done in attempting to produce anew the varieties of cultivated plants by beginning with the wild plant and conducting the work under critical scientific conditions. This is perhaps impossible in the case of our most important plants which have been cultivated since prehistoric times, and of whose original form we are in many cases ignorant, but it is surely a feasible and logical method of procedure in the case of plants domesticated in recent times. * * * *Phlox drummondii* is a native to Texas and not very variable,so far as known only pink, purple and red varieties existing wild. It was introduced into cultivation about seventy-five years ago. There is now a bewildering array of color varieties, both with entire and with fringed petals. In the so-called star of Quedlinburg varieties the central tooth of the fringed varieties is prolonged into a lobe as long or longer than the petal. In the wild form there is apparently no hint of such a character. It ought to be no difficult task to repeat the evolution of these forms under test conditions and thus get a full record of what takes place. * * * Aaronsohn has recently discovered in the mountains of Palestine what are probably the wild originals of wheat, of barley, and of rye. As this country long ago was explored botanically, the question at once arises, why were not these plants found? Aaronsohn offers a humorously simple explanation, namely, that no botanist ever collects a cultivated plant and no agronomist ever looks at a wild one. Perhaps a similar explanation may account for our ignorance of corn and other American natives in the wild state.

* * *

"It seems to me that we too often err on the side of making phenomena appear more simple than they really are. Plants are vastly more complex organisms than our formulated ideas recognize. Many of their phenomena completely baffle us. I think we ought to give such phenomena (as aggressiveness of plants introduced into new localities) more consideration as they reveal traits that transcend all of our sterotyped and inadequate theories. The old gardener often treats his plants as if he regarded them as sentient beings. Perhaps we err in considering them too much as machines. * * * It seems inevitable that a new race of systematic botanists will have to be developed to devote themselves to cultivated plants. We need far more of the facts that can only be gathered in rigid pedigreed breeding experiments. The field of botany in agriculture has not been clear. At the present time it has neither direction nor aggressiveness. What we really need to work on is the science of the breeder's art and the science of the gardener's art. At present, the art is far in advance of the science. But by devoting our science to agriculture and having faith in its potency, no man can foretell the outcome."

"Little Gardens for Boys and Girls," by Myrta Margaret Higgins is a valuable book recently from the press of Houghton, Mifflin Company. It has 150 pages and the price is $1.10. While it is written expressly for children, it contains many excellent suggestions for parents and teachers. There are a few well selected illustrations which, with the clear style of the author and the large type, commend it to children. Many a child who is led to make this book a companion will be kept from roaming the streets because of the interest to be found in a little piece of ground in the rear of a city home, and conversely, city lots that were formerly weed wastes may become things both useful and beautiful. It is to be hoped that the book will have its merited sale.

Massee has published a work entitled "Diseases of Cultivated Plants and Trees" (602 pp., The Macmillan Co., $2.25), which is a full handbook of the fungous diseases of plants, with chapters on such subjects as epidemics, dissemination of diseases, fungicides and spraying. Under each disease is given an account of the general morphology of the organism by which it is caused, together with a description of the symptoms and treatment. A particularly helpful feature of the book is the literature references under each disease. It is particularly comprehensive as respects the fungous diseases that have come to the attention of British botanists at home or in their colonies, diseases due to bacteria, nematodes and other organisms, however, receive rather scant treatment.

NOTES AND COMMENT.

The earnest efforts of the Secretary of Agriculture,seconded by those of a large number of investigators in the Department of Agriculture and by teachers in the agricultural colleges and the universities of the country, are undoubtedly resulting in the collection of an enormous number of important facts in plant physiology, which is everywhere recognized as the scientific basis of progress in practical agriculture, and yet the status of the real science in the United States today is by no means encouraging. It is doubtful if one could name off-hand more than half a dozen universities in the whole country in which an adequately trained plant physiologist is employed. Even in the few institutions in which plant physiology is recognized and provided for as a distinct department, the incumbent is in nearly every case so loaded down with the teaching of botany that he can give only a fraction of his time to the advancement of his science. As an example, the plant physiologist at the University of Michigan is the professor of botany and is responsible, directly or indirectly, for the botanical training of numerous teachers, forestry students, pharmacists and various others. Such time as he can wrest from his multitudionus duties is heroically given to investigation, but the fearful odds under which he works are sure to prevent the successful output of finished work that might otherwise be accomplished. At Stanford the case is similar, though probably the professor at that institution is somewhat less hampered by administrative work. At Harvard the new man appears to have been appointed more because he was a good teacher and could be depended upon to keep a lot of beginners interested than through any expectation that he would have time and means to build up his work in plant physiology.

Not to go through a longer list of institutions, it appears at this writing that Johns Hopkins University stands almost alone in its recent establishment of a department of plant physiology the head of which is expected to devote himself to this one thing, and has not been loaded down with so many other duties as to make creditable progress impossible. Such a condition of affairs does not encourage us to look forward to a creditable development of this most important subject in any reasonable time and to the extent which ought to be aimed at.

If we attempt to analyze the cause of this untoward state of affairs there appear to be two chief reasons. In the first place it is evident that the university authorities in general have no adequate conception of what it is all about, and doubtless consider that if provision is made for a department of botany in which plant physiology shall be taught in connection with other branches of the subject they have fulfilled their duty. For this they are probably less to blame than are the botanists who accept such positions on such an understanding. The subject is too broad, too difficult, and too important to be treated in this way.

And here lies the crux of the whole situation. Young men who become interested in botany during their college course seldom realize until it is too late the extent and nature of the preliminary training that is imperatively required to make any real contribution to the science of plant physiology. This has been aptly designated as "applied physics and chemistry," and it is self-evident that anyone who is not thoroughly grounded in these sciences need not hope for proficiency in the science in which they are the indispensable groundwork. The remedy seems simple, though it may not be easy of application. It involves on the part of botanical teachers faithful and continued reiteration of the conditions of success in this great and difficult field, and a realization on the part of the student of the price of high attainment in it, coupled with a determination and persistence such as is seldom exhibited, even by botanists, at the present day. There is crying need in the United States at the present time of a considerable number of trained plant physiologists. There is absolutely no danger that the thing will be over done. The subject is commended to the attention of earnest and competent students, who instead of putting in two or three years of graduate work, or even less, and then dropping into an experiment station or a college, are willing to take the six years or more that are imperatively required for thorough preparation for the work of a plant physiologist. The labor is great but the reward is sure.

The daily papers are giving interesting reports of the visit to the United States of Mr. S. B. Dicks, who represents the great seed firm of Taber and Co., of London. This house has been in existence since the time of Queen Elizabeth, and may have sold seeds to Shakespeare. For a long time the seeds handled by this firm were grown in Europe, but now, chiefly on account of more favorable climatic conditions, the industry has been largely transferred to California. Seeds of onion, lettuce, sweet pea and aster are among those that are now raised in California for the whole world.

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TRAVEL NOTES: RURAL ENGLAND.

By W. A. Cannon.

While passing several weeks awheel in England, during the months of June and July, I had a good opportunity to see, in an intimate way, a good deal of the rural portion of the country. Speaking literally, it was only a passing glance, but the impressions of green roadsides and fine gardens, of plains, downs, moors, and braes were so pleasant, that I have thought it worth while recording some of them for the benefit of botanists who may not have had the opportunity to see England so favorably.

Beginning our journey at Barnet, a suburb of London, we went in a northerly direction along the eastern side of the country. The route included several interesting cities among which were Bedford, with its memories of Bunyan, Cambridge, where we visited the botanical museum and the college, and a few towns best known abroad for their ancient cathedrals. At Durham we turned further inland, crossing the old Roman wall near the ancient Roman camp at Corbridge, and traversing hilly Northumberland to Melrose and Glasgow. The route ran into Scotland as far as Callander and the Trossacks. Returning to Glasgow we went south through Ayrshire to Carlisle and the English Lake District of Westmoreland and Cumberland. We left the coast country about 100 miles south of Grasmere and crossed the central portion of England to Lichfield, then to Warwick, Stratford-on-Avon and Oxford. From Oxford we went westward across the Berkshire downs and the plains of Salisbury to Stonhenge and Salisbury. Finally, from the latter place, our route lay directly for London by the northern edge of New Forest and Winchester. As thus traversed, the journey was nearly 1,300 miles of good roads, few large cities, and through a country always interesting and often unexpectedly wild and picturesque.

The conditions of plant life in the portions of England visited are surprisingly varied. These are due, among other causes, to the differences in latitude, to varied relations to the sea, to topographical variations, which are really considerable, and to the varied character of the soil. With these should be included differences in rainfall and temperature, also relatively great. What further environmental conditions there are, can not be stated here exactly; certain of them will appear incidentally, however, in the course of these notes.

The country between Barnet, where the tour was begun, and Durham is, for the most part, flat or gently rolling. It is under a high degree of cultivation, and, in June, the small fields are green from the young crops of barley and wheat. The roadsides are bordered with hedges of white and rose haw, and haw hedges also separate the fields. Between the hedgerows by the roadside and the smooth road there is a narrow strip of grass which is often carefully cut and exactly edged as in the city parks; where less care is taken, which fortunately is perhaps usually the case, the hedges are the hiding places of wild roses, and many small plants, as violets, white daisies, cowslips, strawberries, yellow mustard, and yarrow, which are left to flower in the grass. No native forest was seen in this portion of the journey, but trees are often to be found along the roads, or by the sides of the fields, with the hedges, and one often sees woods of a few acres extent which have been planted and left for game preserves. These "plantings" are snugly protected by high fences, and warning signs are a familiar sight throughout England. This suggests the idea that hunting is here taken seriously. The landlord lets his fields for farming purposers to one set of tenants, and the same land to quite another class for hunting grounds. In the autumn the hunt, with high-born ladies and gentlemen, picturesquely attired, and fine horses, gay grooms and bellowing hounds, make, as a countryman assured us, a brave sight. But these riders break down hedges and ruin crops, if there chance to be any on the course, without reimbursing the farmers, so we are told, which fact did not strike our informant as in any degree unjust.

Beyond the Tyne, near which we crossed the remains of the old Roman wall, we had our first view of moorlands—a formation we were to see for several days in different localities along the Scotch-English border. The Tyne separates the moorlands from the less hilly country to the south, and is the logical, if not the actual, boundary of the two countries. We had no sooner crossed than the change was evident in the broad Scotch dialect which assailed our ears, in the different occupation of the farmer who was here a raiser of sheep, and also in the character of the country itself. To the south of the Tyne a feature of the country is the abundance of plantings and the evident fact that the general conditions of plant life are favorable; but as one gets into the Cheviot Hills haw hedges give way to stone walls and, except for more favorable valleys, trees are absent. Generally speaking the bleak character of the country increases with altitude and is most noticeable in the highlands, as where the road crosses the pass at Carter Fell, at an altitude of 1,250 feet, and enters Scotland. From the pass we had a fine view of the moors, where rounded hills mounted hill on hill until, somewhat to the east and north, they culminated in mountains 2,600 feet above the sea. Through the country traversed, up to the moors, it was always evident that the primitive character of the vegetation had long since been lost, but in the moorlands there is yet much that is wild and not at all suggestive of long occupation by man. The moors, in fact, constitute as distinct a type of formation as plain or desert, and are probably quite as tenacious of their leading characters.

The plants at Carter Fell, and in a few other places on the moorland, are probably to be considered as representatives. The mass of the vegetation was seen to be low grasses and sedges. Here and there are large masses of bracken, and, especially on the summits, heather in flower in the middle of June, little more than 20 cm. high. Sphagnum moss is abundant where the contour of the ground permits the accumulation of moisture.

The climate of the moors is apparently a severe one. We were told by a shepherd, in whose hut we found protection from a passing shower, that the snows of winter were very heavy and that snow often lingered on the ground on northern exposures until summer.

From Carter Fell the road descends rapidly and in the Tweed drainage there is abundant evidence of milder climatic conditions. Some of the finest oak trees we found on the trip were at Dryburgh, on the Tweed, where one may now see druidical remains in the form of sacrificial altars and mounds. Along the valley of the Clyde, also, the trees, especially alders, beeches and oaks, are plentiful. Private parks contain many introduced forms like rhododendrons, which grow finely, yews, and the Cedar of Lebanon and its allies. The winding valleys, with still more winding streams, where there are many large and well kept estates of which we got glimpses through roadside hedges, the few ancient castles, doing duty no longer, the ruined abbeys and quaint towns, all conspired to make of this a most picturesque and romantic countryside.

We first saw braes at Bannockburn, where the anniversary of Bruce's victory was being celebrated as we drove through the village, and at Sterling, a short distance beyond. A comprehensive view of these braes, those of the Forth, is to be had from the old castle at Sterling. To the east and to the west, for many miles, the floodplain stretches, and through it the serpentine river makes its slow way to the sea. Mountains and hills bound the plain, those on the west being among the highest in Scotland. In the far west we saw the shimmer of snow on a mountain which lay in the direction of Ben Lomond. This was June 25th.

Among the braes on our way to Callander we passed at first through a farming country, and later through a country somewhat hilly and with fine trees in small plantings. Callander is a few miles beyond the braes and is on the edge of the lake district of Scotland. Immediately to the west lie Loch Vennachar, Loch Achray, and Loch Katrine, and the Trossacks, celebrated for their beauty. We made an excursion on foot from Callander to the Trossacks and Loch Katrine. By the roadside were many species of flowering plants, among which were two or three orchids. The mountain slopes above the lakes are, in places, densely covered with trees, which appear to be natural forests, of what sorts we did not learn, and by the sides of streams and the lakes were groups of birch, alder and beech. We passed, also, the edge of an extensive oak forest, mostly of small trees, where the bark was being harvested. Selected trees were marked and the bark removed from branches even as small as one's finger. Men, women and children were employed at the task. They carried the bark on their backs to drying-racks and from these to large piles, often for long distances. After these operations were over, a rather sparse stand of trees was left for future crops.

To one unaccustomed to the higher latitude, the days at Callander seemed extremely long. What time in the morning the sun rose in June I did not learn, but the setting was late, and twilight was long, so that on June 25th, we could read by the windows in our rooms as late as 10:30. On about that date the lighting up time for motors was not until 10 o'clock.

From Callander we returned to Glasgow, where we visited the University and saw the large botanical building under the guidance of Dr. Lawson. From Glasgow we crossed the beautiful country of Ayr, which resembles in many ways the Tweed valleys and adjacent highlands, and the Clyde valley. The bottom lands have a wealth of vegetation, but the uplands are essentially moors, where one finds bracken and occasionally heather. Where planted on the uplands, the larch and pine grow well. We visited several localities in Ayrshire, among them Manchline, where we saw at Mossgiel the daisy field made famous by Burns, and there picked some of these flowers which richly covered field and roadside. Between Dumfries and Carlisle we re-entered England, and as we drew near Carlisle saw the shallow pits where beat was being cut and the piles of peat drying for market. The industry was apparently a new one at the place.

The mountain region of Cumberland and Westmoreland, the Lake Country of England, was next visited. The Cumbrian mountains, the highest of which is given as being only 3,210 feet, are picturesque. The summits are rounded, the valleys are usually narrow and tortuous and many expand to hold pretty lakes. In the valleys are many attractive estates where one finds large oaks, alders, birches, and a variety of conifers, among the trees, and a large number of luxuriant rhododendrons. We climbed Helvellyn (3,118 feet) and were interested to note the entire absence of trees and shrubs, even of the heather on its upper reaches. Grass and sedges were not very luxuriant; bracken occurred in masses, especially near the base of the mountain, where it was harvested and carefully dried, for what purpose we did not learn. As well as could be determined by the aid of a good glass, the other mountains were provided with a similar covering of plants. As on the other uplands visited, the raising of sheep is here nearly the only occupation of the farmers. This fact may explain in whole or in part the lack of shrubs on the mountains.

From Westmoreland, we drove south not a great distance from the coast through a very disagreeable colliery district to the neighborhood of Liverpool where we turned inland and crossed middle England in a fairly direct line to Oxford, passing *en route* through Lichfield, where Erasmus Darwin lived, Coventry, and Stratford-on-Avon.

At Oxford, as at Cambridge and Glasgow, we visited the colleges and the botanical museum and garden. In the garden, among other foreign trees, are several conifers familiar to Americans, such as the big tree, the redwood, the Monterey cypress, and the Port Orford cedar. The museum, inadequate in size, is being replaced by a large one, which, when completed, doubtless will be adapted to the needs of a large department.

From Oxford the way lay over the downs of Berkshire to the Salisbury plains and to Salisbury. The downs recall the moors of the north, in that they are hilly, but are unlike the moors in that they are arable and are the seats of large farms. No large plantings were observed, and few trees grew by the roadside. The plains were also rolling, but trees were more numerous and occasionally small plantings were seen. Near Salisbury are the ancient stone circles of Avebury, said to be the largest in England, and Stonehenge, which lie on the open plain and command extensive views. From the supposed use of the circles it seems probable that anciently, as now, the plains were treeless, so that the views from them in those times might have been unobstructed.

From Salisbury, "Old Sarum," we went through the northern edge of New Forest, which is said to owe its origin to William the Conqueror, where for several miles we drove through the heavy oak and beech woods, the most extensive, perhaps, in

England. The undergrowth was thick, and the lower story of brackens luxuriant.

Passing through the beautiful country of Hampshire we entered Surrey and near Farnham had the opportunity of visiting a large and old country seat. Here Cedars of Lebanon, yews and oaks, known to have been planted late in the 16th century, still guard the fine lawn. Willows line the stream at the foot of the garden, where an under-shot water mill, working unceasingly, pumps water for the house, and the lily pond now well covered with Lemna. By the kitchen garden, high-walled and well filled with familiar small fruits and vegetables, we found several century plants, oddly out of keeping with the surroundings, which the head gardener was patiently waiting to see bloom. We remarked the small size of the holly and the fact that we had not seen any mistletoe, and the gardener told us that it did not occur naturally in that vicinity, but was customarily planted for market. Our informant told us that the seeds were placed in slits cut in the back of the small limbs of fruit trees, after which they were covered as a protection against birds. No difficulty was experienced in getting the seeds to sprout. It required two or three years after planting before the plants were of sufficient size to use. The large place was owned by a wealthy gentleman who leased it, and when asked how the grounds and the farms were so well cared for, we learned that the chief caretakers, such as the head gardener and assistants were in fact leased with the property, and that some of them may have always lived on the estate, however many lessees there may have been. Thus the planting of trees to take the place of others which are older and in the course of years must disappear, and the setting out of trees in "plantings," of which we had seen so many, goes on automatically and with an affectionate care entirely foreign to us in America. So, with the green fields, roadside flowers and hedges of haw and alder, as an element in the beauty of England, must be counted the trees which here find congenial surroundings. We greatly enjoyed the large oaks, maples, beeches, and elms, which are a familiar sight, but chiefly the chestnuts which are especially beautiful in May and June when in flower, and which are perhaps the trees most frequently met. Of the shrubs we found the most popular to be species of rhododendron, which are used in private parks in great abundance throughout the region visited.

Bruges, August 17, 1910.

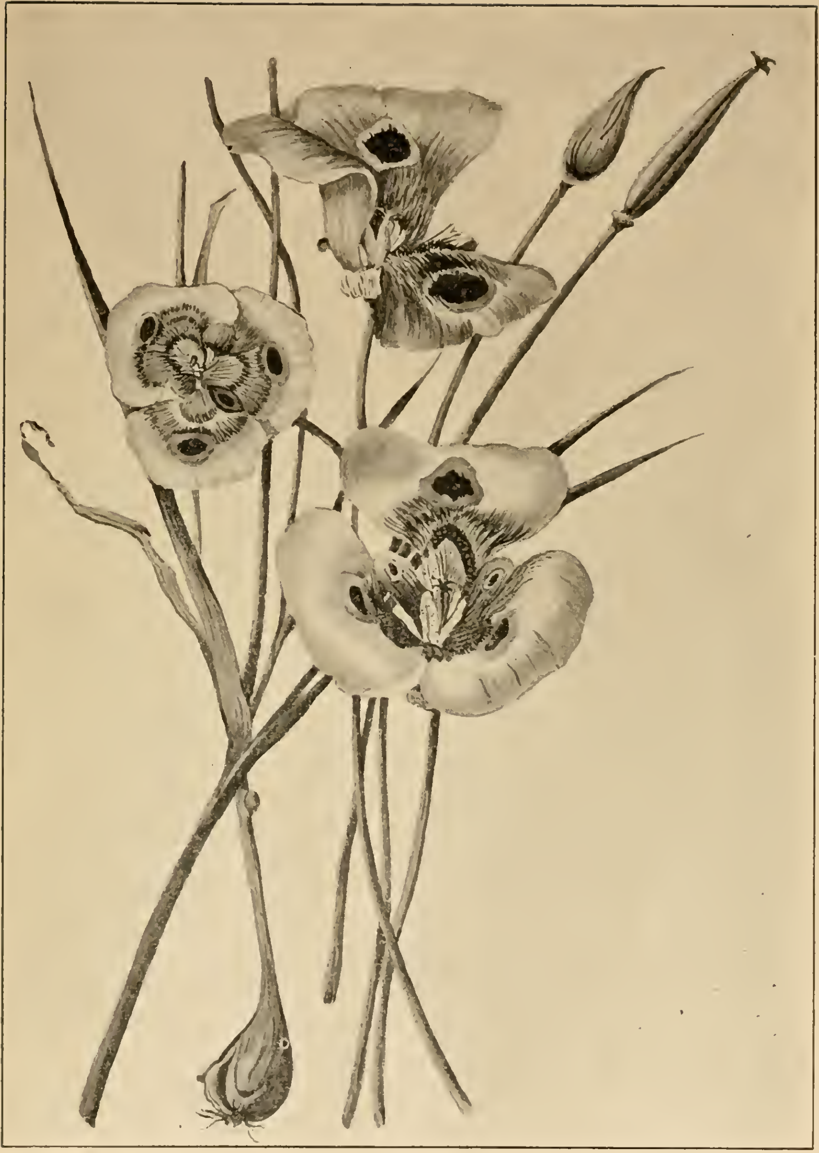
CALOCHORTUS VENUSTUS, A BEAUTIFUL CALIFORNIAN PLANT.

BY JOHN A. SPRING.

Pursh gave us our first knowledge of the plants comprised in the genus Calochortus, in his "Flora of North America," published in 1814. In his preface he speaks of Calochortus as a "bulbous rush;" and in the main body of his work describes the genus as new, and derives for it a name from the Greek roots signifying "pretty grass." It must be remembered, however, that Pursh himself was never west of the Mississippi river, where alone the members of this genus are found, but that he became possessed of the specimens collected by Lewis and Clarke in their celebrated expedition in 1804-5, from which material his descriptions are drawn. Although Pursh could have known the plants only in their dried state, we can see by the name which he gave the genus that he was struck by the beauty of these new specimens in spite of their unfavorable condition.

Even in its fresh, living state the species described by Pursh was not equal in beauty to the subject of the accompanying illustration, a plant which was first discovered in southern California by David Douglas, a collector for the Royal Horticultural Society of London, who sent seeds of it to that body. Plants raised from these seeds in the gardens of the society about 1832 were described in their Transactions a few years later by Bentham under the name *Calochortus venustus.* Many other species of Calochortus were discovered by Douglas and some additional ones have been found by later explorers, until the number of known species, according to Mr. Watson's enumeration, is now thirty-two.

Calochortus venustus adds to its beauty the charm of variety, for no two flowers are exactly alike in form or color. The three flowers shown in the accompanying plate were gathered from



CALOCHORTUS VENUSTUS

separate plants, and show, even in reproduction, by half-tone, their striking differences. The lower one was nearly white in its ground color, with triangular spots on the petals, which are loose and barely touch one another when expanded. The upper flower is purple, and the spot is broadly oval, while the colors at the base are pencilled in a delicate manner. The third flower is smaller, its petals overlap one another, the spots are much longer than wide, and all the colors are more distinctly outlined.

The beauty of the species of Calochortus struck the early Mexican inhabitants of California, and it is to them that we owe the common name "Mariposa," which is to say "Butterfly." Although they are now commonly known as "Mariposa lilies," it requires but little botanical knowledge to recognize in the number of petals and the tunicated or coated bulb their closer relationship to the tulips, from which they differ but little save in the size and development of the petals and sepals.

Soldiers' Home, California.

EVAPORATION AND PLANT HABITATS IN JAMAICA.

By Wm. H. Brown.

With the increasing evidence that evaporation offers an important criterion for comparing the climatic conditions of plant habitats, it seems desirable to accumulate data on this subject from as many regions as possible. An opportunity to study, for a brief period, the evaporation rates with reference to vegetation in the tropics was presented by the Johns Hopkins University Botanical expedition of 1910 to Jamaica, under the leadership of Prof. D. S. Johnson, upon which expedition it was the writer's good fortune to be present. Besides obtaining some information on the evaporation rates in two very different tropical habitats, it was possible to observe the behavior of Prof. Livingston's recently described non-rain-absorbing atmometer in a region and season of frequent, though not exceedingly heavy showers.

The observations were continued for three weeks and four days, beginning May 22, last, by means of the porous cup atmometer of the common form * and also with the non-rain-absorbing instrument. * The evaporating surface in both cases is a porous clay cup, so connected by means of rubber stopper and glass tube to a water bottle at a lower level that the cup is kept constantly filled, the water evaporating from the moist clay surface being replaced from the bottle. Readings are taken by filling the bottle to a file mark on its narrow neck. Entrance of rain water around the cork stopper into the reservoir, was prevented by means of an apron of waterproof cloth. But this arrangement does not prevent the backward flow of water through the cup and tube during showers, so that the ordinary form of instrument may be always expected to absorb rain water to some extent. The non-rain-absorbing instrument practically obviates this difficulty by the insertion of a mercury valve between the reservoir and cup, which allows free movement of water from the former to the latter but not in the opposite direction. The instruments stood side by side in their respective stations and were so placed as to give the evaporation rate at a height of from 15 cm. to 25 cm. above the ground. Filtered rain water was used in the instruments, distilled water not being at hand.

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*Livingston, B. E. A simple atmometer. Science, N.S. 28:319-20. 1908.

————. Operation of the porous cup atmometer. Plant World, 13: 112-118. 1910.

The two stations were located on the grounds of the Cinchona Laboratory of the New York Botanical Garden, in the Blue Mountains. One of these was in an open, grassy clearing, in the vicinity of the laboratory buildings, the other in a deep, densely wooded ravine, about two miles from the first. At the first station sunshine and wind had free access to the instruments, at the second these were almost completely excluded by the ravine walls and by the dense vegetation. Here the temperature was constantly much lower and the humidity higher than at the station in the open, and the plants were usually covered with a water film. While the soil in the open was covered with grasses of ordinary types, that in the ravine bore a variety of extreme tropical mesophytes.

The instruments were read weekly for three weeks, from May 22 to June 12, and records for a final period of four days were also obtained. Likewise, approximate measurements of the amount of precipitation at each of the two stations were made. During the operation there was no period without rain,

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*Livingston, B. E. A rain-correcting atmometer for ecological instrumentation. Plant World, 13: 79-82. 1910.

although the amount of precipitation was not excessive for the tropics; the operations were necessarily discontinued before the summer rainy season was well advanced. At the end of the first two weeks all cups were replaced by new ones and at the end of the entire period all were recalibrated at the Desert Laboratory. No changes in the coefficients of correction were manifest at the final calibration, so that the readings have been corrected by means of the original coefficients. The corrected increments of water loss for each of the four instruments, are presented in the table, which also includes the derived evaporation rates in centimeters and inches of depth from a ten-inch tank. (For the non-rain-absorbing instruments, for the method used, see Livingston, 1910, p. 115). The rainfall for the different partial periods and for the two stations is also given, as well as all totals for the whole period of 25 days.

PERIOD	STATION IN OPEN.					STATION IN RAVINE.				
	Ordinary Atmometer Vol. cc.	Non-rain-Absorbing Atmometer.			RAIN.	Ordinary Atmometer Vol. cc.	Non-rain-Absorbing Atmometer.			RAIN.
		Vol. cc.	Depth mm.	Depth in.	cm.		Vol. cc.	Depth mm	Depth in.	cm.
May 22 to May 29	50.2	54.9	7.77	0.31	0.7	2.9	5.5	0.78	0.03	0.8
May 29 to June 5	41 4	47.5	6.73	0.26	6.5	0.0	4.1	0.58	0.02	4.4
June 5 to June 12	38.1	50.0	7.08	0.28	3.4	0.0	5.8	0.82	0.03	6.6
June 12 to June 16	50.0	53.6	7.59	0.30	0.5	1.4	3.8	0.54	0.02	0.2
Total May 22 to June 16	179.7	206.0	29.17	1.15	11.1	4.3	19.2	2.72	0.11	12.0

It will be observed from the table that the evaporation rate in the shaded ravine was exceedingly low. The highest of the weekly rates was 5.8 cc., though the calculated weekly rate corresponding to the short period would be 6.7. The latter rate is less than a single cubic centimeter per day. The average daily rate for the entire twenty-five days was 0.77 cc. in the ravine and 8.2 in the open, the latter rate being 10.6 times the former. While the rate in the open appears large by comparison with the insignificant amount recorded in the ravine, a comparison of this with the rates which are on record for other regions (made possible through the kindness of Prof. Livingston in furnishing the writer with unpublished data) shows that even the rate in the open at Cinchona must be considered as relatively low. From a series of evaporation rates for various stations in the U. S., carried on from the Desert Laboratory in 1907, in which series the instruments used were essentially the ordinary form of atmometer as used in Jamaica, the following selections have been made for comparison. The instruments in 1907 were operated in the open, at about the same height above the soil surface as in the present series. Of course there is an unknown error in the case of the data of 1907, due to the absorption of rain by the cups.

For the four weeks from May 19 to June 17, 1907, nearly the same season of the year and length of period as that covered by the Jamaica observations, the daily rate at Cold Spring Harbor, Long Island, varied from 15 cc. to 28 cc. and gave an average of 21 cc. Similar figures for West Raleigh, N. C., show a variation from 13 cc. to 29 cc. and an average daily rate for the four weeks of 22 cc. The rate at West Raleigh thus appears nearly thrice as great, neglecting the rain error, as at Cinchona. The daily rates at Tucson, Arizona, for the three weeks from May 26 to June 17, 1907, were 41, 50, and 40 cc., respectively, giving an average of 44 cc., or a rate about 5.4 times as great as in the open at Cinchona. At Tucson the rain error was a vanishing quantity at this season of the year, if, indeed, it was not actually nil. If we consider the ravine habitat in Jamaica as a type of habitats with very low evaporation rates, and the habitat in the open at Tucson as a type of the other extreme, we may conclude, in very general terms, that the range of evaporation rates for the various unsubmerged plant habitats throughout the world may be between the limits of the order of one and fifty or sixty.

The results presented in the table give clear evidence on the importance of the rain error in the operation of the ordinary porous cup atmometer. While the general relation of the two evaporations rates in the two Cinchona habitats would appear approximately the same from the readings of either instrument, yet the numerical relations of this factor in two such habitats must approach the truth much more nearly when the non-rain-absorbing instrument is used. These results, which embody the first test of the new instrument in habitat study, are strongly in favor of its general use.

The writer wishes to express his thanks to Prof. B. E. Livingston for assistance and advice in the preparation of the instruments and otherwise, and to Mr. L. W. Sharp, for his kindness in attending to the apparatus during the latter portion of the period of observation.

The Desert Laboratory,
Tucson, Arizona.

A BOOK FOR TEACHERS OF BOTANY. *

By G. J. PEIRCE.

This book appears, virtually re-written, in a second edition. In paper, binding and letter-press it conforms to the standard of the publishers. In contents it is unusual.

Professors of botany in American colleges may be divided into two classes, teaching botanists and botanists who do more or less teaching. Of the former class I believe there are comparatively few, of the latter, many. A "Professor of Education" is alleged to have said that he had finally become convinced that it was advisable for a person to know something of the subject which he or she taught, in addition to knowing the methods of teaching. This remark, whether or not correctly attributed to a "Professor of Education," is scarcely more preposterous than the practice of many of us of doing the best we can with some knowledge of our subject and only inspiration as to the methods of teaching it. Most of us give little or no attention to the topics especially treated in this book, trusting to the interest of our subject and to the contagiousness of our own enthusiasm. Fortunately enthusiasm is tolerably contagious among young people; but as to the interest of our subject—how successfully some of us conceal it from the world! The means of concealment are various. Some of these are discussed, with great good humor, in this book by Ganong, a teaching botanist, a man possessed by a very contagious form of enthusiasm, a man through whom the many-sided interestingness of our subject shines undimmed. So much for reflections about college teaching.

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*The Teaching Botanist. By W. F. Ganong, Professor of Botany in Smith College. (The Macmillan Company, New York, 1910. $1.25 net.)

The teacher of botany in the schools will, I think, feel fewer pricks and prods of conscience on reading this book than his supposedly more fortunate colleague in a college. Instead, he will be cheered and stimulated by it, he will catch still more of the enthusiasm which made Ganong write it, and he will learn of new sources of material and of new means of help for his work.

Following an introduction in which the futility (or worse) of courses in "nature study" in the lower schools is admitted but the sanguine view is expressed that this condition is temporary, is a series of "chapters on subjects important in botanical education." The first, an essay on the place of the sciences in education and of botany among the sciences, shows that the interest of the child and young person in everything about him naturally gives our subject a place in the curriculum of the schools as well as of the colleges. A fruitful comparison of the matter and methods of the natural sciences leads to the conclusion that the descriptive science of physical geography, the experimental sciences of physics and chemistry, and the observational sciences of zoology and botany, offer varieties of training, as well as of information, from which the schools which can not offer all should select by groups rather than by subjects. The argument for a full year of zoology or botany, in preference to a half-year of each, is well stated; the method of the two being substantially the same, the possession of a reasonable amount of information in one subject is more desirable than glimpses of the content of both.

In the chapter on "what botany is of most educational worth?" a familiar question is once more discussed. A teacher's antecedents and associations so affect his conclusions that his answer to this question must be individual rather than general.

An idea of nature as it is now, rather than of the course of its development is what most people wish first to secure. If the latter can come with the former, so much the better; but the former is as likely to be incomplete as the latter if the latter receive the major emphasis in the arrangement and conduct of an elementary course in botany in school or college. Furthermore, no adequate idea of the vegetation of today can be obtained without the sight of living plants in more than microscopic masses. Greenhouse, garden and park should not only be drawn upon for material, but intelligently visited; and trips to the fields and woods, even if they resemble picnics, may be picnics in which nature receives more emphasis than sport.

The next two chapters, on the training and on the traits of the good botanical teacher, and on the methods of teaching, should be conscientiously read. I prefer to suggest this wholesome reading rather than prevent it by any summary.

Then come chapters on drawing and description, on laboratories and their equipment, on collections and other illustrations and how they may be obtained, and on botanical books and their use. This chapter contains a good bibliography.

The last chapter treats of some common errors prejudicial to good botanical teaching. Beginning with the ancient misconception of what botany is, Ganong disposes also of the question "of what use is it?" and then passes on to discuss various mis-statements of the facts in morphology and physiology.

In Part II, Ganong gives the plan for a general elementary course in botany. This is in two divisions, from which the teacher is to make and combine selections according to the circumstances in which he works and in such fashion that his pupils will gain some familiarity with the structure and functions and habits of plants, of the spore-bearing as well as the seed-bearing. In the appendix are given the course in general botany recommended by the Botanical Society of America and adopted by the College Entrance Examination Board, and the course formulated by a committee of the Association of Colleges and Secondary Schools of the North Central States.

Here and there throughout the book one finds frank acknowledgement of the intellectual stimulus and satisfaction in the study of plants, of a development of mind and character which comes of a truer idea of nature. The reviewer would have liked to find a stronger statement in the book, to see among his colleagues a greater realization of the intimate relations of our science to life, a demonstration in class-room, print, and practice of its usefulness when it is properly conceived and sympathetically taught. But since one result of reading the book is a share of Ganong's enthusiasm, perhaps reflection upon it will lead to the perception of the importance of our subject, of its usefulness to our fellow men.

Stanford University.

BOOKS AND CURRENT LITERATURE.

The Vegetationsbilder of Karsten and Schenk (Fischer, Jena) has been brought to the seventh and eighth series which include the following parts, each with plates and descriptive text:

VII.—1 and 2. The occupation of volcanic soil in Java and Sumatra.
  3. The Northern Black Forest.
  4. Pictures of vegetation in Dalmatia.
  5. Character plants of the Abysinian highlands.
  6 and 7. Plant formations of eastern Bolivia.
  8. Pictures of vegetation in Danish West Greenland.
VIII.—1. Arid steppes of the Kalihari Desert.
  2. Pictures of vegetation in the Juan Fernandez Islands.

Chiti, in the new Journal of Italian Botany, treats of the seasonal dimorphism of *Galium palustre* which he regards as a collective species that in Europe may be separated into three elements of which *G. palustre* and *G. elongatum* are to be considered as seasonally dimorphic, the latter appearing in areas of common distribution about two weeks later than the former. Their geographical distribution leads to the conclusion that their origin is connected not merely with the season, but with the climate. In cultures continued for two years the characters of *G. elongatum* remained constant. In nature, however, the occurence of intermediate forms, not hybrids, suggests that heredity is not absolute in this plant. but is limited to certain groups of species.

Kryz, in the Zeitschrift fur Pflanzenkrankheiten, describes experiments on the influence of kerosene oil on the development of *Datura stramonium* and *Alisma plantago*. He concludes that kerosene renders the soil physically and physiologically dry, resulting in checking the growth of the plant, but that there is no proof of its direct poisonous effect.

Durand, in "Botanical Exploration of the Congo," states that this region is so vast that the materials thus far accumulated are absolutely insufficient to admit of exact conclusions regarding the distribution of its species. Nevertheless, his statistical review, based on studies thus far made (North to the French Congo and Southwest to Angola), is of much interest. The tropical African species number 1,355, and include 390 of wide occurrence in the whole of tropical Africa, 180 that may be designated as South tropical, and 785 as Western tropical. Of these 785 species, 109 represent types widely distributed in the whole of western tropical Africa; 491 western and northern types which appear to find on the Congo their limit of meridional expansion; 185 types of Angola which appear not to pass farther north than the colony of the Congo. If we add to these groups about 105 species which inhabit not only the tropical region but also other regions of the dark continent, both north and south, we should have a total of three thousand African species. There are on the Congo 17 species which are also found in Belgium and 23 in other parts of Europe. There are also 122 which occur both in Asia and Africa of which 20 widely distributed in Africa are unknown beyond Arabia. Mention may also be made of 61 species scattered throughout the tropical regions of the Old World, 55 species found in all tropical regions with the exception of Australia, and 120 species widely distributed in the tropical regions of both hemispheres; to this last group belong 43 cultivated species, the origin of which is unknown. There are also 84 species which occur on the Congo, in the Antilles, and in Central or South America, but 20 of these are introduced species.

As reported by Paulsen in the Botanisches Centralblatt, an attempt has been made by Raunkiaer to place the treatment of plant formations, hitherto largely subjective, upon a solid foundation of statistical determination. The mode of procedure is described as follows: "A frame whose surface measure is one-tenth of a square meter is thrown at haphazard fifty times, and for each throw all species found within the frame are noted. Thus the dominating species will be noted fifty times or only a little less, the rare ones only some few times. Different methods and frames of different square measures have been tried. Small frames and many throws give more correct numbers than larger frames, this being controlled by short counting, but for practical use the author finds fifty throws of a frame one-tenth of a square meter sufficient." By this means the dominant species of a given formation as well as those of subordinate rank, are clearly indicated with practically complete elimination of the personal element.

The action of the legislature of Michigan in 1905, in requiring the State Geological Survey to extend its scope so as to include a biological survey of the state has been amply justified during the few years the law has been effective, and conspicuously so in the case of the recently published *Report on the Geology of Tuscola County, Michigan*, by Charles A. Davis. The eighth chapter of this report is devoted to the native vegetation of Tuscola County, which, from its position in the "thumb" of Michigan, with Saginaw Bay on the west and Lake Huron on the east, and the peculiariteis of its recent geological history, presents an *ensemble* of environmental conditions which render of special interest the author's study of plant distribution in the area under consideration.

Discussing the influence of climatic factors, Dr. Davis shows that the temperature effects of Saginaw Bay, though less than those observed in the part of the state lying near Lake Michigan, are such as to be distinctly felt, and are apparently the cause of the occurrence of the "prairie" flora of the area immediately adjacent to the marshes of Saginaw Bay, far to the north of any similar group of plants known to exist in that region. Some of these plants are more than a hundred miles north of the nearest outside stations known for them.

The rainfall, which averages about 32 inches, is fairly evenly distributed throughout the year, but there are sometimes periods of several years in succession when the precipitation is less than the average by several inches. This condition of affairs, together with the fact that in the county are numerous sandy areas the soil of which quickly dries out, has resulted in a conspicuous representation of xerophytic types.

It is a matter of much interest connected with the study of local distribution that the different soils in the county, which are of many types, from coarse bouldery gravel to fine clay, and from dry, barren sands, through rich, black loam to wet clay and pure organic materials, are arranged in a series of long narrow strips, often very sharply defined, on which there is a zonal arrangement of plants corresponding to these types of soil and to the ground water level determined by the physiographic development of the area studied. The resulting variety of conditions is reflected in a great variety and heavy growth of native vegetation. The whole region before its settlement was heavily timbered. A dense forest of elm, black ash, soft maple, sycamore, swamp oak, white ash, basswood, and other water-tolerant trees which occupied the heavy, undrained, or poorly drained, clay soils near the bay and extended to some distance inland. Penetrating this forest on the ridges, where the drainage was good, was the beech and maple forest, the beech often dominant, or associated with elms, bur and red oaks, or, on the drier areas, with hard maples. In this mesophytic forest white and black oak often appeared, and still more frequently the white pine, which became dominant where the sandy elements of the soil were in excess; and in some instances, as in the Cass valley, a pure white pine forest—practically a xerophytic coniferous forest—occupied considerable areas. The swamp coniferous type of forest was represented by relatively restricted areas of tamarack, arbor vitæ, and black spruce, in wet swamps and along the margins of small lakes. Finally ,a remaining type, the xerophytic, broad-leaved forest, in which oaks were dominant, was sparingly represented on certain areas, where, however, it appears neverto have been able to maintain itself to any great extent in competition with the white pine.

Equally instructive, but too extended to admit of reproduction here, are the author's investigations of other plant associations, the value of which is enhanced by his extended report of exact observations over various areas subjected to special study. The paper as a whole should be thoroughly read and digested by botanical students who aspire to successful work in this fascinating but difficult field.

Ornamental Shrubs of the United States by the late Austin Craig Apgar is a recent book from the press of the American Book Company. There are 342 pages and over 600 figures. The mechanical work is well done. Two short chapters are devoted to leaves, flowers and fruits, after which follows a very complete key to the genera. The remainder of the book, comprising nearly 300 pages, is taken up with descriptions and illustrations of the various shrubs. This work is prepared especially for the non-technical reader to whom it will render a great service, though it should prove even more useful to horticulturists and plant growers.

As viewed from the writer's experience in the southwest with ornamental plants, there are certain important features in which the book is lacking. Some of the cuts, including those of the tamarisks, prickly pears, acacias, willows, and such other common plants as button-bush, and matrimony vine are of poor quality, and mean little even to the experienced reader. This could be overlooked, however, if the author had shown as intimate a knowledge with the living plants under cultivation as he did with their classification, but in this he failed. There is almost nothing with reference to the adaptability of ornamental shrubs to the widely different sections of our country as concerns soil and climate. Occasionally the indefinite statement is made that a plant thrives in the south. Nothing is said concerning the frost-resistant qualities of the various species of Pittosporum or Acacia, nor of drought or alkali enduring properties of such important plants as tamarisks. The usual mistake is made of referring to the western locust (*Rabinia neo-mexicana*) as a "prickly shrub five or six feet high," when it often grows into a tree 30 feet or more in height. Many of the common names are mere translations of the scientific names of the plants, which at best is poor. All this justifies the writer in making the above criticism of a book which might have been made very much more useful.

NOTES AND COMMENT.

Dr. W. A. Cannon in a personal letter says in regard to certain things noted in his recent trip through England: "There are two points which I should have accentuated in the paper. One of these is the abundance of Cedars of Lebanon, the probable reason being their introduction by the crusaders many centuries ago. I found them pretty much throughout England. The other is in reference to the value of Stonehenge as an indication that the plains of Salisbury were not forested when their prehistoric builders lived there and when the Roman soldiers had their camp at and around 'Old Sarum.' This did not strike me as being of special interest when I wrote it, but now it does."

Readers of the PLANT WORLD who have been impressed with the luxuriant growth of pepper trees in the southwestern United States will be interested in an extract from the Los Angeles Herald: "After having withstood the blasts of over half a hundred winters two pioneer pepper trees of the San Bernardino valley are being felled because they have become so infirm that they may be uprooten at any time. The two trees were the first of the pepper variety to be planted in the valley and were the first to be brought to California. They were imported from the Sandwich Islands and planted in San Bernardino in 1856. The children of three generations have played beneath the stalwart and stately old trees, but public safety finally demanded that the pioneers of all pepper trees in the valley be felled."

There is a refreshing naivete in some of the passages of Metchnikoff's interesting book on the Prolongation of Life. After discussing at some length the general subject of natural death among plants and concluding that various yeasts and microbes which perish in an excess of their own secretions are to be thought of as victims of auto-intoxication, he raises the question whether the natural death of higher plants, "usually attributed to exhaustion, can not be explained more simply as the result of poisons produced in their metabolism," but adds "that the natural death of the higher plants, is the result of auto-intoxication, is a mere hypothesis which future investigations may disprove. If, however, it comes to be confirmed, it would explain the coincidence of death and fruceification more simply than the hypothesis of predestination."

Like words from the golden books are the closing sentences in the retiring adderss of T. G. Bonney as president of the British Association for the Advancement of Science in which he discusses at length certain difficult questions interesting alike both to botanists and geologists. To quote in part: "I think we shall be wiser in working on in the hope of clearing up some of the perplexities. * * * There are some stages in the development of a scientific idea when the best service we can do it is by attempting to separate facts from fancies, by demanding that difficulties should be frankly faced instead of being severely ignored, by insisting that the giving of a name can not convert the imaginery into the real, and by remembering that if hypotheses yet on their trial are treated as axioms, the result will often bring disaster, like building a tower on a foundation of sand."

Skottsberg's Studies of the Plant Life of the Falkland Islands indicates that the land flora of these islands is to be reckoned as a part of the Magellan-Falkland province of the Subarctic South American region, and that it is composed of the following elements: Magellan steppe plants, 47 species; species of the littoral formation of the forest region of Tierra del Fuego; forest moor plants, 24; Tierra del Fuego alpine plants, 5; Tierra del Fuego forest plants, 6; land plants of wider distribution, especially such as occur in other extra tropical parts of South America, 14; widely distributed water plants, 5; endemic species, especially such as occur in other extra tropical parts of South America, 14; widely distributed water plants, 5; endemic species, 10.

The University of Wisconsin is further justifying contemporary fudgment as to its place in the fore-front of American State Universities by the erection of a new biological building, 42 by 240 feet in size, with four stories and a basement, and with facilities for regulation of environmental conditions. There are to be six greenhouses and rooms for studying the effect of different light on plants and for the investigation of other problems in plant physiology, in addition to ample provision for modern zoological work. It is a pleasure to think of the admirable facilities provided at one or more neighboring state universities for advanced work in the humanities and in certain physical sciences and in professional lines, but the old fire-traps in which some of the ablest specialists in zoology and botany in the country are still compelled to conduct investigation and give instruction are, to say the least, an anomaly in what are understood to be progressive institutions of the twentieth century.

That scientific training—and not only this, but training in biological conceptions and methods—is good for that class of people whose heads are apt to be in the clouds, with no certain relation to the earth, is exemplified in the case of Professor William James of Harvard, who more than most philosophers, kept his feet on *terra firma* and talked intelligible English. Receiving his early education in the Lawrence Scientific School, a pupil of Agassiz, whom he accompanied on one at least of his expeditions, a graduate of the Harvard Medical School, and for some time a teacher of human physiology, his thought was characterized by a clearness and directness that can hardly be looked for on the part of those who attempt to develop philosophical systems without first coming in contact with the realities that are inevitably encountered in the practical study of such a subject as physiology. It is said that he took special interest in "obdurate details." Would there were more like him!

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AN EFFECT OF CEMENT DUST ON ORANGE TREES.

BY GEORGE J. PEIRCE.

As this country becomes more thickly settled, the various occupations of the inhabitants inevitably press more closely upon each other, overlapping and even interfering with one another, as the population and the occupations grow. Thus, the town encroaches upon the country, the factory on the residential section. The wastes of civilization spread much further than those directly engaged in the production of those wastes. Thus, the smoke of cities spreads out over the surrounding country, dimming the sunlight and vitiating the air, impairing the fruitfulness of fields and orchards, as well as destroying the comfort of existence.

The disposal of sewage we plainly recognize as one of the duties of a civilized community, and in many cities the checking of the soot nuisance, commonly spoken of as smoke ordinance, is plainly recognized; but how few realize that the smoke nuisance is not fundamentally a problem of the disposal of the solid wastes of our commercial and domestic fires, but rather of the empounding of those gaseous wastes, which, when freely discharged into the air poison it for long distances.

Other forms of industry discharge their liquid, solid, and gaseous wastes under only partial control, so far as laws and ordinances and the will of the people go, the only control being an economic one; for when the loss of waste becomes unprofitable, then, and then only, are steps taken to prevent or reduce it. When it is considered to be cheaper to let the waste go, although it may be of an almost finished product, no steps are taken to check it; it continues until others find it a nuisance and protest against it. Instances of this sort are becoming increasingly numerous, because people and industries are coming closer together, affecting each other more directly than when there was so much more unoccupied territory in our country.

An instance of this sort has come to my notice within the last year. In the San Bernardino Valley in Southern California, the principal occupation of the people is the growing of citrus fruits. The bulk of the yield is oranges, lemons and grapefruit being produced in less quantity. Orange culture in this valley was established before any manufacturing interest was begun, and many groves of orange and lemon trees had already reached productive and profitable development before any industries not connected with orange culture had come into the valley. Of late years, however, with the very rapid increase in the use of cement, cement manufacturing plants have been established and operated in this valley, as well as elsewhere; and those that have been established longest have been greatly increased in size and output.

The manufacture of cement, as ordinarily practiced, is a very dusty business, and unless special pains are taken, the dust will not be confined to the limits, or even to the immediate vicinity of the works. Owing to the nature of the business, the dust which escapes will contain a fair proportion of a product so nearly finished that a film of this dust will set when moistened. No ordinary dust from road or field would do so. The dust will settle close to the works, or far away from them, according to the fineness of the particles, and according to the wind. There may even be a difference in the proportion of finished product which settles near the works, and that which is carried farther away, because of the difference in the size of the particles. Everything in any way exposed in the neighborhood of such works presently becomes covered with a thicker or thinner layer of this dust, to the inconvenience of the housewife as well as of the worker in field and orchard.

As one goes by Southern Pacific train from Los Angeles to Colton, one passes orange grove after orange grove, the dark, glossy foliage of which gives the landscape a beauty and a character quite unusual. Suddenly one notices, on looking out of the car window, that the leaves of the orange trees are no longer green and glossy, but that they are gray and dull. The green is concealed. On the other side of the train one sees a cement works from which, by night as well as by day, a cloud of dust is rising. This cloud drifts in one direction or another, according to the prevailing wind, the greatest amount of dust falling from this cloud nearest the works, the finest particles being carried farthest away. Further along the same line of railroad, the foliage in the orange groves is fair and green. The contrast between the uncovered, undusted foliage of orange, lemon, and grape-fruit, and that which is coated with a crust, much of which is composed of cement, is very great.

The particles of dust falling on the smooth and glossy upper surface of the shiny leaves of these citrus fruit trees, accumulate after a time into a layer of considerable thickness; these particles cohere and set in dew or fog or gentle rain, adhering to the surface of the leaf in rather a surprising degree. In fact, the adhesion is often so great that it is not possible to remove the crust completely from the upper surface of even such smooth leaves as these. I have repeatedly tried to remove the crust completely from the thickly coated leaf, and have rarely been able to do so without damage to the leaf itself.

Even a thin crust of cement is fairly opaque. To prove this, it is only necessary to rub off as completely as possible, the cement from one half of an orange leaf and then to hold the leaf up to the sun. One will at once notice how plainly the oil glands show in the clean half of the leaf, and how indistinctly they can be seen, if seen at all, in the coated half. Such an opaque crust interposed as a screen over the upper surface of the leaf can not fail to reduce the amount of light entering the leaf. When one realizes that the manufacture of a non-nitrogenous food by green plants is dependent upon the absorption of energy from sunlight, one can realize also the possibility, if not the probability, of the interference of such a crust with the manufacture of sugar in the leaves. If the manufacture of non-nitrogenous food is interfered with, all the other activities of the plant are correspondingly affected; for upon the manufacture of non-nitrogenous food depends the construction of cell-wall, the supply of material to which nitrogen is added in the manufacture of proteid, and in the further elaboration of the complex constituents of protoplasm. Interference, then, with the manufacture of non-nitrogenous food, that is, with the manufacture of sugar, is an interference with an early and a fundamental stage in the process of nutrition. This interference stops, or at least proportionally decreases, all of the other numerous processes dependant upon it.

These speculations as to the interference of a thin but opaque coat of cement with light absorption and with the manufacture of food may readily be converted into proof. If one gently washes the coating of cement from one side of the midrib, from base to tip, of the upper surface of an orange leaf, without disturbing the coating on the other side, and taking pains that the process of cleaning the leaf does not injure it or its attachment to the branch, the leaf remaining undisturbed upon the tree throughout the following day,one will be able to see bya comparison of the amounts of starch in the cleaned and uncleaned halves of the leaf, how much food has been made in each.

This can be done by making sections of the two halves of the leaf, decolorizing and staining with iodine, clearing, and counting the number of starch grains in individual cells; or one may even attain the same results, although not with the same accuracy, by decolorizing the unsectioned halves of the leaves, treating them with iodine, and then clearing again by the well-known method of Sachs.

Since the starch made during the day is removed from the orange leaf during the night, and the starch found in an orange leaf at the end of the daylight hours of the day represents the amount which has accumulated in its cells since morning, a comparison of the cleaned and coated halves of the leaves at the end of the day, is not only fair but instructive, it shows what the cells in these two halves have been able to do under conditions which differ only in the one respect, that the entrance of light into the cells on one side of the midrib has been interfered with, or prevented, and on the other side has not. Counting the grains of starch in mesophyll cells in sections through the washed and through the unwashed halves of orange leaves shows that the cells in the washed half contain four or five times as many grains of starch as those in the covered and shaded half.

Here, then, is the proof that food manufacture at the very beginning of the series of processes which we collectively call nutrition, is interfered with. The degree of interference is indicated by the difference in the amounts of starch in the two halves of the leaf.

This decrease in the amount of food made daily in the leaves of orange and lemon and grape fruit has resulted in a decreased yield, as well as in a decreased growth of the trees. I am told that the yield decreases in spite of cultivation being continued with care, skill, and thoroughness. Indeed, the growers, finding their crops decreasing, appear to have employed every possible means of cultivation, fertilization, etc., to maintain the productiveness of their crops, but in this they appear, without exception, to have failed.

In a note published in *Science* in November, 1909, I spoke of the possible effect of cement dust on plants growing in one of the fertile valleys not far from San Francisco. The major part of the vegetation, both native and cultivated, of the valley described in that paper is composed of annuals or of plants which lose their leaves annually. In that paper, also, I spoke of the fineness of the particles of dust which coated all exposed surfaces in the neighborhood of the cement works there. I was very much interested to compare with the varied and deciduous vegetation of the San Ramon Valley, near San Francisco, the peculiar and homogeneous evergreen vegetation of the San Bernardino Valley in Southern California, both as to the vegetation itself and also as to the effect of dust upon it. The more or less permanent coating of leaves which last for two or three years, or possibly longer, with an opaque crust, will necessarily produce a greater and more continuous effect than a covering which must be renewed with the annual production of leaves.

In the case of deciduous leafed plants in the San Ramon Valley, near San Francisco, I was not able to carry on any experiments, owing to the lateness of the season, but my repeated visits to the orange groves of the San Bernardino Valley have made it possible to show, as I have above described, one result of the interference of one industry with another. There may be other effects produced by the dust which escapes from cement manufactories, but the result which I have just now described is both easily demonstrated and greatly to be regretted. It would seem to be necessary so to modify the method of manufacturing cement that this necessary commercial enterprise can be carried on without interference with the rights of others already established in businesses equally legitimate and necessary.

It has been suggested that one way to avoid trouble which the unrestricted operation of manufacturing plants of certain sorts has produced, is for the owners of these works to buy up surrounding country. In such a proposal as this the nation, as well as the individual owner has an interest; for as the nation is interested, as a consumer of food, in the production of food in sufficient quantity, at a sufficiently low price to insure its being obtainable by all, so the nation is directly concerned in anything which may interfere with the production of food. When land which is best suited to the production of food is bought by a manufacturing concern and made idle by the operation of the works, the food supply of the nation is correspondingly decreased. If the principle of buying out producers who might otherwise interfere with or make trouble for the owners of manufacturing works is indefinitely extended, we shall find the area from which food can be supplied correspondingly decreasing. In this there seems to be a principle to be very carefully considered before the practice is allowed to extend.

Stanford University, California.

THE EFFECT OF CEMENT DUST ON CITRUS TREES.

By S. B. Parish.

Slover Mountain is an isolated upheaval of limestone, rising abruptly from the fertile mesa lands of the San Bernardino Valley. Its altitude is perhaps 500 feet, and its circumference is some two miles. From its very base, mile after mile, extends an almost uninterrupted succession of orange and lemon orchards. Some years ago a small cement mill was built at the northern foot of the mountain, and it has grown, with the increasing demand for its product, to be an establishment of considerable size; and now a still larger mill has been built on the southern side of the mountain. From these mills dust is poured forth in vast clouds, which is carried by the winds over the surrounding country, and settles down over everything therein situated. The presence of this dust can be readily detected at distances of three miles, but its seriously injurious effects are limited to within a radius of about one mile from the place of its discharge, the deposit being much heavier within that area.

Professor J. H. Norton ascertained the amount of dust deposited in two orange orchards near the mills by exposing during one week a number of glass plates, coated with vaseline and placed horizontally on supports about three feet high. At fixed intervals, the dust thus collected was removed, freed from the vaseline, dried and accurately weighed. From data thus obtained it was found that the annual deposit of dust per acre in these two orchards was 2.39 and 3.18 tons respectively.

So serious was the resultant injury to the groves that their owners were obliged to apply to the Superior Court of the county for an injunction restraining the cement company from continuing to discharge dust from their works. The testimony of more than 150 witnesses was taken at the trial, and in this number were many of the most experienced growers and packers of citrus fruits, as well as several botanical experts for either side. Some of the facts brought out are not without interest to the plant physiologist.

The cement dust is deposited mostly on the upper surfaces of the leaves, and microscopic examinations showed that the stomata, which are all situated on the lower surfaces, were not clogged, so that there was no evidence of interference with respiration or transpiration. Nor was any effort made to show that the dust in any way hindered the pollination of the flowers, except that it was said to deter the visits of bees. But in the present case this was unimportant, as most of the varieties of oranges and lemons grown here are seedless varieties and produce their fruit without pollination. From a botanical point of view, therefore, the whole case narrowed down to a consideration of the effect of the dust in interfering with photosynthesis.

Cement dust differs from other dust in that by absorbing dew and the hygroscopic moisture of the atmosphere, it forms on the leaf surface a hard, opaque, pellicle which is not removed by rain, and, indeed, not without difficulty by the hand. The life of an orange or lemon leaf is not less than three years, and may exceed that period. It is evident that the coating of leaves of long duration, such as these, with a scale constantly increasing in thickness, is far more seriously injurious than a deposit on leaves which are annually deciduous. This was very evident in the "cement zone," where such deciduous trees as the pear, apple, peach, apricot, plum and fig were but slightly damaged in comparison with the citrus trees. On these latter, one noticed, first of all, a great deficiency of foliage. This is dense in a healthy tree, but, as some of the orange growers phrased it, "one could see right through" the dust-covered trees, many of the leaves falling prematurely. To a marked extent many leaves had failed to develop to their full size, so that there were numerous undersized ones, and these often stood erect, in place of assuming a nearly horizontal position as do healthy leaves. Lemon trees exhibited a twiggy appearance, many shoots being bare except for a leaf or two at the tip. There was a considerable difference of resistance shown by different varieties of the orange, seedling trees suffering the least and Mediterranean sweets the most. But with them all, fruit production, the feature most important to the grower, had greatly decreased, the trees yielding now only about one-fourth as much as in pre-cement years. The fruit has also deteriorated, a larger proportion of it going into the lower grades and the "culls" or unmarketable fruit.

Many of the most experienced orange growers testified that the situation and the soil were ideal for citrus culture, as was evidenced by the former healthfulness and productivity of the orchards. It was further shown that the orchards had been cultivated, fertilized and irrigated in the most thorough and approved manner.

Such being the facts in the case, what was the cause of the miserable condition of the trees? To the plant physiologist the answer was evident and easy. With a rich soil and abundant water the trees were plainly starving because the heavily shaded leaves were prevented from manufacturing sufficient carbohydrates to maintain a healthy growth.

On the removal of the cement scale the leaves were seen to be in a more or less chlorotic condition, showing a deterioration of the chlorophyll to etiolin. Dr. Peirce's careful microscopic examinations demonstrated that a leaf whose surface was cement coated produced but one-fourth as many starch granules as an equal area of clean leaf. Thus, deprived of the normal number of its leaves, with those that remained reduced in area, and with three out of four of its chloroplasts inhibited in their activity, it was impossible that a tree should have a vigorous life and produce an abundant fruitage.

Incidentally the subject of road dust was taken up, and the horticultural experts agreed that the dust blown from a traveled highway caused the two or three bordering rows of trees to yield less fruit than the same number in the interior of the orchard. One grower had found that it paid him to oil the road passing by his grove in order to prevent this dust. The injury from road dust is, however, much less than that caused by cement dust, as it does not form a scale, and is readily washed off by the winter rains.

Some testimony on the effect of cement dust on the natural vegetation was not without interest. A slope of the mountain directly facing the old mill, and which receives a very heavy deposit of dust, was occupied by a nearly pure growth of *Artemisia californica*. The leaves of this plant, which are narrowly linear, are heavily laden with dust which, however, does not form a scale on them. When cleaned they have a yellowish, sickly color, yet the plants survive, and are not noticeably diminished in number by their copious deluge of dust. This may, then, be counted a dust-resisting species. The next slope, having a different aspect, was formerly covered with *Encelia farinosa*, *Salvia apiana* and *S. mellifera*, all suffrutescent plants with wider and roughened leaves. Under the dust showers the two latter species have entirely disappeared, and of the former only a few sickly and dying specimens yet remain.

It appears then that while different plants offer a varying degree of resistance to the deleterious effects of cement dust, all are injured, those whose leaves are deciduous much less than those with persistent leaves. Certainly none are benefitted, as was absurdly claimed by a witness for the defense. The orange and lemon trees whose vigorous life demands an abundant supply of plant food, are peculiarly affected by this interference with that supply. They have become weak and unproductive, and their death is but a question of time.

San Bernardino, California.

SEED DISTRIBUTION BY THE UNITED STATES DEPARTMENT OF AGRICULTURE.

BY A. J. PIETERS.

As early as the administration of John Quincy Adams in 1825–29, instructions were sent to the consuls of the United States to forward rare plants and seeds to the Department of State for distribution, but no action was taken toward an appropriation until 1839 when a bill setting aside $1,000.00 as a part of the appropriation for the patent office, for the "* * * procurement of cuttings and seeds for gratuitous distribution among farmers" became law. The original intent of the law was that the Commissioner, later Secretary, of Agriculture should attempt to introduce new varieties of plants, such as gave promise of adding to the agricultural resources of the country. The term "new and rare" varieties was used in all the appropriation bills until 1896, but since that time it has been left out.

The seeds a d plants purchased under this appropriation were sent to farmers and others for testing, but there was no special distribution through members of Congress. Just when this came about has not been ascertained, but the practice of securing names of good men for testing and reporting upon the seeds and plants from members of Congress doubtless grew up naturally, as they were most likely to know the best men in their sections. It was also natural that farmers and horticulturists wishing seeds and not knowing where to apply should appeal to their congressman, who would transmit the request. However that may have been, it is certain that the sending of seeds to constituents became very popular with congressmen, and that the practice grew very rapidly, since during the year 1910 a total of 60,620,000 packets of vegetable and flower seeds were sent out, almost all of them through members of Congress.

The original intent of the bill was good and a great deal of good was done under the early appropriations. This was true even after the seed came to be sent out through congressmen. During the early years of the work it was due to this free distribution that many valuable introductions of seeds and plants were made. Among them are sorghum, the annual value of which will run over $40,000,000; Japan rice, worth over $5,000,000 a year to the country, besides the immense increase in the in the value of the land devoted to its culture; durum wheat, worth over $10,000,000 annually; and various varieties of wheat, oats and barley. One of the most striking of the introductions made by the Department of Agriculture is the Washington or Naval orange so extensively grown in California. These are but a few of the introductions that for one reason or another it has been possible to locate; there are undoubtedly many other varieties that were sent out and found their way into culture without any record of the fact being kept.

Not only did the distribution do a great deal of good in the past but it is still doing good. It must not be forgotten that there are two lines of seed distribution being carried on by the Department of Agriculture, the one of vegetable and flower seeds through members of Congress, the other the introduction and distribution of new varieties through the Office of Seed and Plant Distribution. The latter is a continuation of the original intent of the bill, while the former exists for no reason save that some members of Congress believe that their political interests are served by sending seeds to their constituents. It is possible that a friendly eye might see some good in the annual distribution of more than a million pounds of common garden seeds, and that here and there some one may be found who would not have lived as near to nature and so much in his garden if he had not received these seeds, but the good done, if any, is so small in proportion to the cost, and in proportion to what could be done with the same amount of money in legitimate lines of seed introduction that on the whole we must regard this distribution through members of Congress as useless, and a waste of the public funds.

While there is no doubt that much good can be and is being done through the distribution of seeds and plants, it is apparently hopeless to expect any good from a distribution through members of Congress. The pressure on the administrative officers to increase the numbers of packets sent out will be so strong that it would be impossible to confine the distribution to new and rare varieties. These cannot be had in sufficient quantities, and if they could the cost would be prohibitive. When the writer was in charge of this work he presented to the Chief of the Bureau of Plant Industry a plan looking to the gradual replacing of the quotas of vegetable and flower seeds by smaller quotas of forage and grass seeds accompanied by expert demonstrations of the value of these crops in the Congressman's district. The idea was that the Department should expend the amount of money required for each quota of vegetable and flower seeds in demonstrating the value of a new farm crop to the constituents of a member of Congress and in distributing seeds of this crop to them. It was not possible to carry out this plan, however, because while the members were willing that this demonstration work should be done they wanted their regular quotas of seed too. The valuable results from the introduction of new crops must be looked for in the office of Seed and Plant Distribution. This office works in harmony with the various crop experts of the Department and makes a systematic effort to fill each need as it arises.

At present the Congressional Free Seed Distribution requires 50,030,000 packets of vegetable and 10,590,000 packets of flower seeds to fill the quotas. There are 20,000 packages of vegetable and 2,000 packages of flower seeds to each senator and member of Congress and 1,000,000 packages of vegetable and 150,000 packages of flower seeds for the Secretary of Agriculture. Each of these packages contain five packets. The quantity of seed needed to fill these varies with the sorts purchased each year, but is in the neighborhood of 1,250,000 pounds of vegetable and and 43,000 pounds of flower seed. Beside the vegetable and flower seeds there are put up some other seeds in smaller quantities and a certain number of bulbs. The appropriation is large and the work has to be rushed through in a comparatively short time, so that it is particularly necessary that the organization of the work should be good. This is the case, and the men engaged in the administration of this office deserve more credit than they often get for honesty and efficiency. It is gratifying to record that although there are perhaps few offices in the service where there are more opportunities for corruption, there has not been a suggestion of it in this office since the work was placed in the Bureau of Plant Industry.

In order to send, as far as possible, the varieties that are best for each section, the United States is divided into districts. For each district several combinations are made up, each combination consisting of five varieties. These combinations are made up in the fall of the year previous to that in which the seeds are to be sent out. By counting up the total number of packets of each variety needed to fill these combinations the quantity of seed of each variety required can be readily determined. Bids are then asked for from the wholesale trade for the seed needed. As a rule part of the seed is bought out of the supplies on hand for delivery in the following summer and part of the seeds are grown especially for the Department. When the seeds are received they are tested for purity and vitality, purity in this case meaning mechanical purity, not the purity of the stock. The latter cannot, unfortunately, be determined until the seeds are sent out. The seeds are packeted by machinery, there being twenty-two machines in operation last year, each with a capacity of 25,000 packets a day. When the machines are all going, it is sometimes possible to run out 1,000 packets a minute. These packets are then assembled into packages, each package containing five packets, and are closed by machinery.

Different officials have from time to time tried to put an end to the congressional seed distribution, but bills introduced for this purpose are promptly killed in Congress. Efforts of the same kind are also constantly being made by the seed trade, but are usually so misdirected as to fail of any effect, indeed they have done more harm than good. The most serious effort was made in 1896 by Secretary Morton, who, failing to receive offers for "rare and valuable seeds" as provided by the letter of the of the law, declared that since the law directed him to distribute "rare and valuable seeds" it would not be right for him to buy and distribute common sorts. He therefore did not buy any seeds and closed the Division of Seed Distribution. Congress, however, lost no time in making it clear that the members wanted the seeds, and did not much care what kind they were. A bill was immediately passed making it mandatory for the Secretary to distribute vegetable and flower seeds, and the distribution went on as before. Since that time the amount appropriated has been largely increased, but the mandatory character of the legislation remains, and the Secretary of Agriculture has no choice but to obey the law. Since the time of Secretary Morton, no attempt has been made to abolish the distribution, but a great deal has been done to keep the appropriation within bounds. In spite of the fact that the appropriation has been largely increased, it is a fact that the officers of the Department have been instrumental in preventing still greater increases. For this they have never received credit. Such work can not be done in the open, and cannot be advertised, but it has been done.

From the nature of the case there have been abuses in the distribution. The writer recalls how one member of Congress now a senator, sent out seven times as many packages as there were men, women and children in his district. This was when he was a candidate for election to the Senate, and he used this distribution to increase his popularity. Another member from one of the prairie states, during a hotly contested election came and frankly stated that he must have several thousand extra packages, as he needed them to help in his campaign. He was an influential member and he got them. It is safe to say that the distribution of seeds through members of Congress cannot be made into anything good. Much good can be done, and is being done, by the distribution of seeds, but it is done by the office of Seed and Plant Introduction and Distribution, and this is carefully kept free from congressional influence.

University of Michigan.

NOTES ON GROWTH OF PINE SEEDLINGS.

BY J. C. BLUMER.

Perhaps no questions are asked by laymen in regard to trees, more than, "How old are they?" and "How fast do they grow?" It is by answers to questions that information may be most fruitfully imparted, and by accurate replies to inquiries such as these that some of the strongest arguments may be developed for the conservation of the forests, and our natural resources in general. In the autumn of 1909, in the Rincon Mountains of Arizona, were found a number of tiny pine seedlings of two species, *Pinus arizonica* and *P. strobiformis*. Some having been pressed and preserved, twenty of them were recently measured. While the drying process shortened them somewhat, this loss of length is not appreciable. Their average height was a very small fraction over one inch (1.069 inches). They were all three years old. Their age was shown by three distinct internodes and as many whorls of leaves. The individuals measured as follows:

ARIZONA PINE, (*Pinus arizonica*)		MEXICAN WHITE PINE, (*P. strobiformis*)	
Seedling No. 1	1 1-8 inches	Seedling No. 1	1 1-8 inches
Seedling No. 2	1 3-8 inches	Seedling No. 2	1 inch
Seedling No. 3	1 1-8 inches	Seedling No. 3	1 1-2 inches
Seedling No. 4	7-8 inches	Seedling No. 4	7-8 inch
Seedling No. 5	1 3-16 inches	Seedling No. 5	7-8 inch
Seedling No. 6	1 3-16 inches	Seedling No. 6	3-4 inch
Seedling No. 7	1 inch	Seedling No. 7	1 3-8 inches
Seedling No. 8	1 3-8 inches	Seedling No. 8	7-16 inch
Seedling No. 9	1 inch	Seedling No. 9	7-8 inch
Seedling No. 10	1 3-16 inches	Seedling No. 10	1 1-8 inches

The long, straight tap roots that the seedlings had sunk were, at the end of three years, at least from four to eight times as long as the portion of the plant above ground. This characteristic feature of most of our western perennials proves that the young trees were by no means idle, but were sinking securely the foundation for future growth. But all of this takes time. All these seedlings began growth in the spring or summer of 1907. None were found to have started since that date, or several years preceding it. Indeed, it is a known fact that pines in general reproduce in certain years only. The right kind of seed, soil, and weather must meet before a new generation unfolds itself. It is by such slow and uncertain methods, yet in the long run and over a wide scope thoroughly effective, that the forest naturally reproduces itself. The process may be assisted by human protection. Recent extensive fires in the Santa Catalina Mountains have destroyed vast numbers of pine and fir seedlings that were already well established in many parts of the forest. Vegetative conditions here being more favorable than in the Rincons these seedlings probably had enjoyed a somewhat more rapid growth than those measured above. But even here the cost of raising and replacing by hand all the trees destroyed would amount to millions of dollars in time and direct outlay.

Tucson, Arizona.

SOME EFFECTS OF PROTRACTED DROUGHT UPON XEROPHYTIC PLANTS.

BY FRANK C. GATES.

From the beginning of the growing season until the latter part of August, 1910, there was a very pronounced deficiency in amount of rainfall in the Upper Lakes Basin which resulted in imposing severe and unusual conditions upon the plants that grow on the beach. Ample opportunity was thus given for observing the external modifications that such conditions would bring about. Many differences were noted, but as far as could be determined they were in relative degrees of characters normal to the plants. Abundant proof was given of the power of beach plants to quickly and seemingly easily respond to a change in edaphic conditions which had taken place within the life of each individual plant.

Taking up in greater detail a few of the commoner plants, the following table sets forth some of the more noticeable changes.

Euphorbia corollata.—The pubescence, which is usually shed at flowering time, remained through flowering into fruiting; stems thicker and red; leaves somewhat shorter and narrower.

Salsola kali tenuifolia.—Lateral roots usually well developed, (7-10 feet long for a plant 3 inches high); leaves wider and shorter; plants more succulent and hairy.

Corispermum hyssopifolium.—Roots longer and stronger, plants more succulent.

Cakile edentula.—Even more succulent than normally.

Euphorbia polygonifolia.—Stems and leaves thicker and more succulent.

Salix syrticola.—Leaves one-half to two-thirds shorter and a trifle narrower.

Potentilla anserina.—Stems much thicker and densely villous-pubescent, internodes of the runners much shorter.

Juncus balticus littoralis and *Scirpus americanus.*—Scarcely a plant but whose stem was spirally twisted. In general much the same could have been said of nearly any plant on the beach.

Chicago, Ill.

THE STRING-BEAN MAN AND HIS WORK.*

By PARKER THAYER BARNES.

They call him the "String-Bean Man"—this tall, compact, energetic horticultural pathfinder, of Leroy, New York—whose name is C. N. Keeney, and who is known far and wide as the man who supplies seed beans to the trade all over the land, but whose fame rests on the fact that he has originated so many varieties of beans which are the delight of the epicure, on account of their stringlessness.

The stringless string-bean, as a commercial product, was evolved only after most painstaking and laborious efforts. For a long time the string was supposed to be a necessary part of the bean; no one expected string-beans without them. Indeed, if such an idea was discussed, the question immediately arose, "would a string-bean be a string-bean if it had no string?" Mr. Keeney, however, with the insight of the true plant-breeder, made up his mind that a stringless string-bean was entirely possible.

Away back in the eighties, after having spent some years in the careful selection of desirable types of standard sorts of beans, and after having produced two or three good, new varieties by hybridization, he continued his experimental work by buying a peck of Refugee Wax beans, which had recently been introduced by one of the most reliable seedsmen in the country, and planted them in a garden spot near the village in which he lives, where he could give them his personal attention. These Refugee Wax beans inherited the string which so persistently and almost universally appears in every new variety in which the Refugee enters as a component part. The prepotency of the Refugee is very strong, and, whenever this variety is crossed with any other, the Refugee characteristics generally predominate. Our enthusiastic searcher after better things realized that this variety would be far more valuable without a string and determined to make a thorough search for a plant with stringless pods.

When the pods on the plants from this peck of seed beans became large enough for use, the search for the stringless pods commenced. On his knees, Mr. Keeney spent hours creeping from one plant to another, breaking a single pod on each plant to find one which was minus the string. Hundreds of plants were tested and passed. How many hundred plants he tested before he received his reward, Mr. Keeney does not know. Indefatigable in his search for the ideal, the fascination of the hunt was so intense that nothing short of absolute defeat would allow him to stop. He had made up his mind to examine every plant in that field if necessary.

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*Reprinted from Suburban Life.

Reward came at last, however, One day Mr. Keeney found a pod which broke clean, and which had not a vestige of a string. He marked the plant, but was not ready to stop there; having found one plant that was stringless, he felt there must be others in the same field, and the search was continued until several hundred more plants had been examined, when a second stringless pod was discovered and marked. To be sure that he had not made a mistake in calling these beans stringless, the plants were visited again in a week, and each tested by breaking a pod, the results justifying his belief that all the pods on each plant were stringless.

He was now ready to go ahead with his work of developing a race of stringless Refugee Wax string-beans. There were two things to be done: First, the stringless characteristics must be fixed; that is the plants must be grown year after year, and the seeds saved from only those which produced stringless pods. The first year all of the beans from the stringless pods were planted and grown under ordinary field conditions. The beans from each plant, however, were planted in separate plots, great care being taken that they should not be mixed. The crop from each plot was saved, and planted separately the following year, the idea being to note carefully the comparative merits of the two families, with the intention of saving only the better one in case they were not alike.

The following year Mr. Keeney had as many plots of beans as he had plants the year before. Each plot was carefully watched, and the plants bearing undesirable pods removed. When the harvest came each plot was gathered separately, only the product of the best plants being saved. Each succeeding year the progeny of the first two plants were grown separately and only the best plants saved. Finally, when the habit of producing stringless beans was well fixed, and the plants were bearing good crops of uniform pods, the best beans from the two lots, having been found to be exactly alike, were combined, and the seed grown from them distributed among the seedsmen, to be sold to the retail trade.

BOOKS AND CURRENT LITERATURE.

Of the numerous recent contributions on the subject of seed growing, we have selected for review a paper by Dr. W. W. Tracy (Bu. Pl. Ind. Bull. No. 184) on The Production of Vegetable Seeds. In the present instance an attempt will be made to select enough of the salient points to report, largely in the words of the author, the most important features of the paper as a record of scientific experiment and experience.

A seed is defined as essentially "a plant packed for transportation." Its good appearance as to cleanliness, plumpness and color is a desirable quality, but one that may be quite misleading as to comparative value. In Red Valentine Beans, for example, a plump, full, symmetrical bean of a bright red color is apt to go with inferior varietal quality, while a twisted, unsymmetrical shape and a dull color are generally indications of a pure stock.

That every grain will under favorable conditions develop into a healthy plant would be regarded by many who have little horticultural experience as the most important of all qualities. But of two lots of seed in one of which 60 to 75 per cent of the grains will develop into plants which are typical of the variety, while the remainder will not germinate at all, and in the other, though every seed is viable, only 10 or 20 per cent of them will produce typical plants of the sort, the others developing into a medley of different forms and qualities, the first lot, though only 60 to 70 per cent viable, is decidedly the most satisfactory and valuable.

Passing from these and various other interesting considerations of a general nature, the author takes up specifically the growing of sweet corn for seed, discussing first the influence of location on quality.

The qualities of sweetness and tendernesss, as well as earliness of maturity, in green corn are influenced by soil and climatic conditions, but there is a difference of opinion as to how far this influence is carried in the seed. The corn packers of Maine insist that green corn grown in the north from northern-grown seed is superior to that which can be produced from seed grown farther south. The Maryland packers insist that they can get not only more but sweeter and more tender corn from seed grown in their own locality. In both cases the superior results obtained from local-grown seed may be accounted for by the fact that seed grown in any locality for a number of generations has been found by experimentation to give better results in that locality than seed of the same stock equally well grown elsewhere.

If we carefully select ears grown from eastern and from western seed which are in exactly the same stage of maturity chemical analysis fails to detect any constant difference in sugar content. There is, however, a slight but discernible difference in the size of the chit, or germ, and in a general way the green corn from western seed is slightly coarser in texture and less tender than that from eastern seed. The difference in quality may be accounted for as follows:

The climatic conditions in the western corn-growing sections especially during the season when the corn is earing, are often such as to induce a marvellously rapid development—much more rapid than is usually seen in the East. In the West it is sometimes difficult to find ears of sweet corn green enough to be in prime boiling condition in fields where it was equally difficult to find ears which were mature enough to be palatable forty-eight to seventy-two hours earlier. Seed grown under such conditions would often transmit the rapid-maturing habit of the plants that produce it. The quality of green corn, particularly as to tenderness and sweetness, is very dependent upon the stage of maturity at which it is cooked, sometimes the growth of only a few hours affecting the discernible sugar content. If the corn in a field from western seed in which the rapid-maturing habit was transmitted was gathered for canning when most of the ears were in prime green-corn condition, some of the ears would be so mature as to lower the average quality, but it would be impracticable to reject such slightly over-mature ears, and the resulting poor quality of the pack would be charged to generally inferior stock rather than to the effect of the few older ears.

The mixture of varieties through cross-pollination is one of the most serious obstacles with which the grower has to contend.

Corn pollen in abundance has been obtained from the plumage of a blackbird, which must have flown between four and six miles from the last field of corn visited, and doubtless others of the large flock to which the bird belonged carried equal quantities of pollen, more or less of which they must have scattered in the field of seed sweet corn in which they alighted.

Experience shows that neither a distance less than several miles nor any varietal difference can be relied upon as a certain protection against a mixture of pollen. In most farming regions it is impracticable to locate a field of corn seed so as to guarantee that there shall be no mixture through pollen, though much can be done to lessen the probability of a mixture. Usually the most practicable way is to plant each lot of seed as far as possible from any other corn, and also to have as much difference as possible in the dates of ripening of the seed corn and of the corn in the nearest field. In sorting before shelling, if kernels of hybrid corn are found in a given ear, it is well to throw out the whole ear rather than to pick out the mixed grain, because crossing does not always change the appearance of the grain the first season, and there is a strong probability that on an ear on which crossed grains are visible there are other crossed grains which show no external sign of mixture.

The direction for growing stock seed are of both practical and theoretical interest and are reproduced in detail.

First, formulate a very clear conception of precisely what an ideal plant of the sort to be grown should be, not only as to grain and ear, but as to stalk, leaf, husk, silk, and tassel, for this is essential to raising the best seed of the sort. With this conception in mind, or what is far better, clearly written out and illustrated by photograph, go into a field of the sort at the time the plants are coming into silk, and mark with a string or a bit of cloth,or in some way a number of stalks. It is wise to select at least a hundred plants which are as nearly alike and typical of the sort as can be found.

When the grain is in the dough state, assemble the marked stalks and, after stripping down the husks, very carefully select and tag those in which the ear and the grain are nearest to the ideal. The ears from each of these selected plants should be carefully numbered, dried and stored. The next spring mark out near the center of the largest available field of the sort a block of

4, 9, or 16 square rods for each of the selected ears, and plant each block with seed from one of the selected plants.

It is wise in making the planting to reserve at least one-fifth of the seed on each ear, not only for re-planting, if necessary, but so that reference may be made to the exact character of the parent stock. When the corn is coming into silk carefully go over the blocks and select those in which the plants in stalk, leaf, husk, silk, and tassel are most uniformly of the desired character, rejecting the plants which show the greatest variation, even if some of them, as will in all probability be the case, are among the most perfect plants in the field.

When the corn is passing into the dough state go over the selected block and, stripping down the husks, select the blocks in which the ears are most uniformly of the desired varietal character, rejecting, as in the selection of the individual plants, all the ears, no matter how perfect they may be, from the blocks showing the greatest variation. As a rule it will be best to select several blocks in order to avoid the loss in vegetative vigor which, in the corn plant, often follows too close breeding.

From the chosen blocks select a number of the most perfect ears, to be tagged, numbered, kept separate, and again planted in separate blocks the next season. The balance of the corn from the selected blocks can be gathered and the better ears bulked and used the following season for planting the field in which the seed blocks are to be located.

Working in this way, never losing sight of or changing the ideal varietal characteristics of the sort, always selecting from the most uniform lot, resisting the temptation to use an exceptionally perfect ear found in a variable block, one can in a few years establish strains which will be greatly superior in practical value to most of the seed now used.

The second half of the bulletin is devoted to the growing of garden beans and peas for seed, and includes important suggestions based on experience in the eastern states, in Cailfornia and elsewhere.

NOTES AND COMMENT.

Reviewing, in *Science*, a recent work on "Concealing-colors," Lewis Agassiz Fuertes says: "If the reader be himself open-minded and, fired by the novelty of the discoveries, try for himself the experiments so graphically described, he will be led irresistably to a sympathy with the enlightened authors, and there will open to him a whole new realm of discovery—he will , in short, be led back to the delightful field of philosophic and contemplative natural history, which, in these days of minute and technical study of classification and relationships, has been nearly if not quite lost sight of." Such an example of intelligent and sympathetic reviewing is a source of great satisfaction. In the present case one is reminded of the brilliant teaching of Tyndall, who, in earlier days, exhorted his students to "do the thing" and they would then know more than he had told them.

It is significant that in his presidential address on "The Flora of the British Islands," before the botanical section of the British Association for the Advancement of Science, Professor J. W. H. Trail took occasion to say "I believe that a well-organized botanical survey of the British Islands would give results of great scientific value, and that there is need for it." This is the ground over which Hooker, Bentham, and a host of other lights at Kew, South Kensington, Cambridge, Edinburgh, and other centers too numerous to mention, have tried for several generations, with no small success, to learn about British plants. It may well be doubted whether there are any areas in the United States upon which a thorough-going botanical survey would not produce results of great scientific value.

The popular journals that are published for horticulturists and lovers of rural life are teeming in these days with all sorts of botanical information, some of it strange, if true, but much of it well worth at least the trouble of looking over. In turning through a pile of these journals, not long since, the reviewer was struck with the interest of some of the articles, one of which, credited to its proper source, appears in the present number of THE PLANT WORLD.

The Annual Report of the Bureau of Plant Industry brings, as usual, a record of progress in various lines of investigation with which botanists should be acquainted. Without attempting a review of the report as a whole, the work on grains and seeds may be selected for brief notice.

Much attention has been given to tests of varieties. For example, experiments on corn at Yuma, Arizona, and at a number of other places, for a period of years, prove that choice of variety alone often decides between success and failure. New varieties have been found to have special characters that adapt them to particular conditions. An interesting example is a variety from Shanghai, China, in which the silks of the young ear are protected by the base of the leaf, thus permitting fertilization without exposure to hot, drying winds which, in the case of other varieties, often prevent pollination, and are among the most serious obstacles to the cultivation of corn in arid regions. Investigations with regard to barley culture have shown that varieties must be bred for the soils on which they are to grow, and that the best results are not to be expected from growing a single variety over a great range of territory. It has been found that under conditions where spring barley fails, winter barley may often be grown with success. The breeding of disease-resistant varieties of wheat and other grains has been continued with hopeful results.

Experiments have been conducted on the influence of environment on the composition of grain. These are of such a character as to permit of the consideration of the soil factor in connection with that of climate in such a way that the influence of each may be determined. The seed laboratory has continued to make tests of seeds sold by local dealers throughout the country. It is found that the differences in the quality of seeds sold by different firms are surprisingly great, the average germination of seeds for three years from one firm being 37%, and from another firm being 81%; the standardization of commercial grains has also made excellent progress. It is plain that applied science under the direction of the Bureau of Plant Industry is abundantly and increasingly justified both in the advancement of knowledge and in its application to the agricultural and horticultural industries of the country.

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